GLENMERE LAKE WATERSHED MANAGEMENT PLAN

DECEMBER 2011
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MMI #4515-01-1

Prepared for:

Orange County Water Authority
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TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

LIST OF TABLES

LIST OF FIGURES

TABLE OF CONTENTS (Continued)

APPENDICES

EXECUTIVE SUMMARY

Study Purpose

This Watershed Management Plan was developed in order to provide objective information and guidance to Glenmere Lake's managers, users and other stakeholders. The Plan provides recommendations for managing Glenmere Lake and its watershed in a manner that will:

1. Provide a sustainable supply of high quality water;
2. Maintain sufficient health and quantity of natural habitats to support recreational activities and wildlife, including game, rare and endangered species, and common species;
3. Maintain the attractive aesthetic appearance of the Lake; and
4. Support sustainable development within the watershed that does not compromise the other objectives.

Background

The Orange County Water Authority (OCWA) developed a county-wide Water Master Plan in 2009 that, among other recommendations, endorsed watershed management plans for all public water supplies. Glenmere Lake was specifically identified as a priority in this Plan. The OCWA funded the development of the Glenmere Lake Watershed Management Plan to fulfill this recommendation while also seeking solutions to lake management issues including water supply, aquatic vegetation, recreation, and rare species.

A variety of investigations and studies have been conducted within and around Glenmere Lake by different entities and for different purposes over the years. This Watershed Management Plan provides an inventory and discussion of such work; presents findings based on existing documents, field observations, and public input; and recommends actions for comprehensive and sustainable lake management.

Existing Conditions and Findings

Glenmere Lake was reportedly formed in the late 1700s when a dam was constructed across Browns Creek, further impounding an existing body of water. Glenmere Lake has multiple uses and functions. The Lake serves the Village of Florida as a sole source of public water and as a recreational resource for fishing, non-motorized boating, bird hunting, and passive recreation. The lake is also a critical open space, providing habitat for a variety of plant and animal species including the endangered Northern Cricket frog (*Acris crepitans*). The Lake and its surrounding landscape serve as an aesthetic amenity to residents and visitors alike. Beyond the limits of the lake's shoreline, the 2.5 square mile watershed supports a variety of residential, commercial, and open space land uses within the Towns of Warwick and Chester and the Village of Florida.

An essential use of Glenmere Lake is as a reservoir. The Lake is the source of public water supply for the Village of Florida (2,820 Village users are served via 1,008 service connections) but also serves the Orange County Correctional Facility, Valley View Nursing Home, Hearthstone Apartments, the Department of Social Services facility, and Emergency Services facility. In 2010,

the lake serviced an average daily water demand of 473,044 gallons per day (gpd) to its users. The Village has had rights to the lake water, water system facilities (including the filtration plant), and distribution system components since 1987, when it purchased the rights from a private water company.

Glenmere Lake provides high quality habitat for a variety of plant and animal species. Perhaps the most noteworthy species living in or around the lake is the endangered Northern cricket frog. This frog's population at Glenmere Lake has been recognized by the New York State Department of Environmental Conservation (NYSDEC) as the largest population in New York State. Dissolved oxygen levels measured in Glenmere Lake in June and August 2011 are generally appropriate to support fish communities.

Submerged and floating aquatic vegetation have been present in Glenmere Lake since at least the beginning of the 20th century. Emergent aquatic vegetation (a category that includes water lilies) has been reported since at least the 1970s or earlier. Over the lifetime of the lake, the areal extent of aquatic vegetation has increased. The majority of these species are native, but invasive Eurasian water milfoil is present in the north-central and northern portions of the Lake. While the extent of the Eurasian water milfoil is relatively limited, it is an invasive plant species that could potentially spread to levels that would negatively impact native aquatic vegetation, fisheries and the lake's overall ecological health.

Stormwater generated in the watershed appears to be relatively unmanaged. More recent developments such as the homes along Horse Hill Lane have been developed with water quality controls, but older developments such as the Glenmere Homesites or the neighborhood around Hill Pond are without stormwater controls. Minor areas of erosion were observed throughout the watershed, mainly along roadways where runoff is concentrated. Recent development pressures have been relatively few in number in the watershed. One significant development is currently pending various approvals (the Glenmere Preserve housing development).

Despite the current state of stormwater management in the watershed, sedimentation and filling of Glenmere Lake have not been significant in the past two decades, based on field work in the summer of 2011 and bathymetric data from 1993. This is consistent with the small watershed and the lack of surface water discharge from large impervious areas into the lake.

Lead Recommendations

General

Modifications to Glenmere Lake's allowed recreational uses are not recommended. The lake is already providing a broad range of recreational uses beyond those allowed for in many public water supply reservoirs. However, individuals who launch watercraft into the lake must take precautions to ensure that non-native species will not be introduced.

Water Supply

As the sole source of public water supply for the Village of Florida, the system lacks source redundancy. Evaluation of an alternate or emergency back-up supply is recommended to reduce

vulnerability. An interconnection with another water utility such as the Goshen public water system, or development of wells, could provide backup supply to the Florida system. An updated calculation of safe yield is recommended to account for reasonable reduction for the volume of water displaced by aquatic vegetation, stream inflows, reasonable releases to Browns Creek downstream of the dam, and a limit on lake level drawdown. Depending on the results of the safe yield analysis, Glenmere Lake could be managed to provide reasonable releases to Browns Creek downstream of the dam.

The Village of Florida should be planning for compliance with Stage 2 of the EPA's Disinfection Byproducts Rule. As such, the Village should focus on reducing TOC in the water near the intake and reducing water age in the extremities of the distribution system. If aeration is pursued by the Village of Florida for control of algae in Glenmere Lake, then it should be constrained to the northern portions of the lake nearest the water treatment plant intake and should be verified as cost-effective.

The Village should conduct annual watershed inspections to identify problem conditions or practices so that they may be corrected.

Aquatic Vegetation

Eurasian water milfoil is invasive and should be removed from the lake using hand or suction harvesting techniques. Its removal is considered the most responsible action to help restore a more natural ecological balance for Glenmere Lake. An aquatic vegetation monitoring program is recommended to document shifts in aquatic vegetation species and density. The monitoring would include both invasive and non-invasive species, and would provide information that could be used to plan future milfoil harvesting.

Application of fluridone is not recommended for Glenmere Lake, as it is a public water supply. The Village of Florida is advised to follow the conditions of its copper sulfate use approvals, and is encouraged to reduce the frequency and concentrations of the applications to the extent possible. Given the low rate at which sediment is accumulating in the Lake, dredging is not recommended.

Habitat

Glenmere Lake's role as habitat for a variety of plant and animal species, including the endangered Northern cricket frog, should not be weakened. Land use management within the contributing watershed to the lake and water quality management in the lake should be reviewed and assessed to maximize water quality and habitat protection for preserving the Northern Cricket frog populations.

Water Quality

A comprehensive water quality monitoring program for the Glenmere Lake watershed is recommended to understand what actions may be needed to protect water quality and plan for future treatment plant upgrades, and help land use planners guide and regulate development and stormwater management. Depending on the findings of the water quality monitoring program, watershed municipalities may wish to assist with stormwater management retrofits or installations where none currently exist. New land development proposals in the watershed should include stormwater controls that address water quantity and water quality.

Because there is limited information to verify the reports of possible septic system-related nutrient contributions to Glenmere Lake, the County should partner with the Village of Florida and/or the Town of Warwick to conduct a sanitary evaluation of the Glenmere Homesites neighborhood to document the condition of septic systems and the potential for releases to the watershed.

Land Management

The Town of Warwick should proceed with its plans to adopt a Public Water Supply Watershed Overlay District for Glenmere Lake and proceed with implementation of its CPPP and prioritize those listed parcels that are associated with Glenmere Lake. The remedial action at the County-owned Brownfield site is consistent with desired watershed and lake management measures and should proceed as planned.

Conclusions

While Glenmere Lake currently has adequate water quality and supply to meet its role as a drinking water source, a host of actions can – and, in some cases, should – be taken to ensure that this role is not compromised in the future and that the ecological, recreational, and aesthetic values of the Lake are not infringed upon.

The gradual rate of sedimentation within the Lake does not warrant dredging, nor does the expansion rate of native aquatic plants endanger the Lake from being able to provide adequate high-quality supply to its customers.

However, both native and invasive aquatic plants are becoming more abundant within the Lake. This issue should be addressed in the near-term, both through vegetation monitoring and by selective harvesting that does not endanger the fragile and rare ecology of the Lake. Chemical applications are not recommended for use at Glenmere Lake, although continued and limited use of copper sulfate is believed acceptable. Aeration may not be an effective method of controlling nuisance plants and should thus be analyzed for its cost-effectiveness.

Managing activities within Glenmere Lake and its watershed to maximize water quality and habitat conservation is consistent with desired water quality protection relative to drinking water supply and for protection of important wildlife such as the Northern Cricket frog and other species.

1.0 INTRODUCTION AND BACKGROUND

1.1 Introduction

A Watershed Management Plan has been developed for Glenmere Lake, located in Orange County, New York. Glenmere Lake was reportedly formed in the late 1700s when a dam was constructed across Browns Creek, further impounding an existing body of water. The lake is the sole source of public water supply for the village of Florida and also provides water to a small portion of the town of Goshen. The contributing watershed to Glenmere Lake encompasses portions of the towns of Warwick and Chester as well as portions of the village of Florida.

The Orange County Water Authority (OCWA) retained Milone & MacBroom, Inc. (MMI) to complete a watershed assessment of the Glenmere Lake watershed and guide the development of a management action plan. OCWA was created to address the long-term water needs of Orange County, New York. OCWA supports local, intermunicipal, and regional water planning and projects and coordinates analysis of county water resources to provide a scientific basis for planning and decision making. Their programs are focused on water supply, water resource protection, watershed planning, conservation, and education. The county consists of 42 municipalities, including 20 towns, 19 villages, and three cities. OCWA is managed by a five-member board of directors and is supported by a chief financial officer, executive director, board secretary, and the Orange County Department of Law.

Under the direction of OCWA, a countywide Water Master Plan was developed in 2009 that identified six key water supply planning initiatives, including source water protection. The plan recommended that watershed management plans be developed for all public water supplies, with priority given to those reservoirs with documented impairments or under development pressures. Glenmere Lake was specifically identified as a priority. The Water Master Plan reported that Glenmere Lake is especially vulnerable to the effects of land use changes but would also be responsive to restoration efforts that target water quality.

The subject document presents the Watershed Management Plan. Work commenced in February 2011 and concluded in autumn 2011.

1.2 Advisory Committee

An Advisory Committee was convened for the Glenmere Lake Watershed Management Plan project, representing a diverse group of watershed residents, ecological proponents, local officials, county and water authority representatives, and state agencies with interest in maintaining high water quality and ecological health in the Glenmere Lake watershed. Table 1-1 lists the Advisory Committee members and their respective affiliations.

TABLE 1-1
Advisory Committee[1]

Committee Member	*Affiliation*
David Church	Orange County Water Authority
Ed Helbig	Orange County Water Authority
Eenika Cruz	Orange County Water Authority
Kelly Dobbins	Orange County Planning Department
Mike Pillmeier	Orange County Legislative Chairman
Bill Rudge	New York State Department of Environmental Conservation
Scott Cuppett	New York State Department of Environmental Conservation
Willie Janeway	New York State Department of Environmental Conservation
Richard Coriale	New York State Department of Environmental Conservation
Jim Pawliczek Sr.	Village of Florida
Michael Sweeton	Town of Warwick
Todd Vogel	Warwick Conservation Board
Ed Butler	Town of Warwick/Tectonic Engineering
Steve Neauhaus	Town of Chester
Laurie Post	Resident

On February 7, 2011 the Advisory Committee and members of the MMI project team met for a project kick-off meeting. At that meeting, the team was introduced, and discussion ensued that focused on lake and watershed needs, priorities, challenges, and opportunities. Subsequent meetings of the committee were held in April and November 2011. An initial public meeting was held in May 2011, at which numerous committee members were present. A second public meeting was held on December 7, 2011 to present the draft plan and kick off a period of public comment.

1.3 Current Issues

Glenmere Lake serves multiple functions and needs. It is the sole source of public water supply to the village of Florida. The lake and adjacent land areas serve as a recreational resource to area residents on and near the lake as well as others from further away for nonmotorized boating, fishing, bird hunting, walking, picnicking, and various forms of passive recreation. It provides habitat for a variety of plant and animal species, including the endangered Northern cricket frog (*Acris crepitans*), and it serves as an aesthetic amenity to residents and visitors alike. Beyond the limits of the lake's shoreline, the 2.5 square mile watershed (approximately 1,600 acres) supports a variety of residential, commercial, and open space land uses.

Given the diversity of existing and potential future uses of Glenmere Lake and its surrounding watershed, it is not surprising that the demands on the water, land, and resources sometimes appear to be at odds with one another. Watershed management

[1] Other interests, including a local organization known as the Glenmere Conservation Coalition, provided information to the study through a few of its members. Although these individuals were not formal members of the advisory committee, their input was valuable to the planning process.

usually involves a balancing of needs and resources, and Glenmere Lake is no exception. Based on review of existing data and information, meetings with project stakeholders, and field investigations, the following primary issues have been identified.

Aquatic Vegetation

Lakes and ponds and the processes occurring within them are the result of geology, physics, chemistry, and biology. Because of their physical shape, lakes and ponds foster the constant settling of suspended particles that become part of the sediment. Lakes and ponds are also catchments for nutrients and solutes in the environment.

While the natural life cycle of a lake includes eutrophication – the process whereby a waterbody's nutrient levels increase through time – and associated increases in aquatic vegetation, these factors can complicate management of reservoirs such as Glenmere Lake if they affect the ability to withdraw adequate volumes of water or if they hinder recreational uses. Anecdotal reports from some residents and lakefront property owners indicate that aquatic vegetation has increased in recent decades and that this vegetation now significantly hinders recreation – particularly boating and fishing – that was once a mainstay of the lake. Other residents and researchers are skeptical that native vegetation as well as invasive vegetation (such as Eurasian water milfoil) pose a threat to the lake.

All lakes and ponds go through a natural eutrophication process whereby nutrients and silt accumulate over time. Premature eutrophication or cultural eutrophication can result from human activities that accelerate the natural aging process of a pond or lake. Accelerated eutrophication is the result of excessive nutrient input to the waterbody from stormwater runoff, septic leachate, and wastewater discharges. Some of the symptoms of lake eutrophication include:

- An increase of algae blooms whereby phytoplankton are produced in great quantities, often turning the lake a bright green "pea soup" color
- Abundant growth of submerged, rooted aquatic vegetation
- Depth shallowing caused by deposition of sand, silt, and sediment on the pond bottom
- Depletion of dissolved oxygen (DO), particularly at lower depths

From a water supply perspective, the Village of Florida is concerned for the long-term viability of its water supply and maintaining the northern deepest section for supply purposes. This led the Village of Florida to petition the New York State Department of Environmental Conservation (NYSDEC) for a permit to apply chemical treatments to the lake water in an attempt to control aquatic vegetation growth. Concerns for water quality and habitat prevented the permit from subsequently being issued.

To develop a better understanding of the reality of existing or future threats from aquatic vegetation, this planning process undertook an initial reconnaissance level study to better understand if and to what extent aquatic vegetation is impacting, or is likely to impact, uses of Glenmere Lake. Potential aquatic vegetation management options were examined relative to ecological sensitivities and drinking water considerations.

Water Quality, Land Use, and Potential Pollutant Inputs to the Lake

The land uses within a watershed are integrally related to the water quality of the surface water runoff and ground water recharge to the waterbody into which they flow. Land uses within the Glenmere watershed are largely residential, with some commercial and agricultural uses, including a horse farm. There are some reports from residents that high ground water and failing septic systems may be a source of human nutrients to the lake.

The role of stormwater runoff and possible sources of erosion has not been well documented in the past. Field investigations conducted as part of the subject management plan evaluated evidence of road drainage, agricultural practices, and instances of shoreline erosion.

While the water quality of the raw water to the village of Florida's drinking water treatment plant is reported to be good and water quality violations are not believed to be a problem, extensive water quality data has not been collected in Glenmere Lake. A reconnaissance-level water quality assessment was conducted as part of this management plan, and recommendations are contained herein.

Ecological Habitat

The ecological habitat of any lake is an important consideration in lake and watershed management and is often a critical driver of watershed management initiatives, zoning regulations, land use controls, and conservation and preservation efforts. The state's largest known population of Northern cricket frogs has been documented in Glenmere Lake. This frog is an endangered species in the state of New York, casting an even greater significance on lake management and land development within the watershed.

The Wallkill River Watershed Conservation and Management Plan notes that the Wildlife Conservation Society has identified high quality habitat throughout the Quaker Creek subwatershed (of which Glenmere Lake is a part) in its Southern Wallkill Biodiversity Plan. "Species of concern" include the Eastern box turtle, five-lined skink, spotted turtle, longtail salamander, Northern cricket frog, wood frog, Upland sandpiper, Indiana bat, and falcate orangetip butterfly.

Development Pressures

A number of development projects have been proposed and/or constructed in the recent past within the Glenmere Lake watershed, including the Glenmere Mansion resort at the

northern end of the watershed, which was recently renovated, and the proposed Glenmere Preserve Planned Adult Community that has not yet received permits for construction. The controversy surrounding both developments underscores the array of interests in the watershed and the sensitivity of the environment from a water supply quality and ecological perspective.

Condition of and Responsibility for the Dam

Glenmere Lake is impounded by the dam and spillway located at the northern end of the waterbody near the Chester/Warwick divide. The ownership of the dam has been disputed. The dam is a 600-foot long earthen embankment with a maximum height of 24 feet and a crest elevation that has been reported as 535 feet. Based upon its proximity to several low lying homes, the dam has a NYSDEC hazard classification of "C" (high hazard). The spillway elevation has been reported at 533.5 feet with flashboards and between 532.5 and 533.3 feet without flashboards. The spillway does not pass the 0.5 probable maximum flood (PMF) design flow.

The DEC has cited the dam as being deficient and in need of rehabilitation. In 2007, DEC brought an enforcement action against the Town of Chester, the Village of Florida, and the Town of Warwick "for failing to operate and maintain the dam in a safe condition." While the structural integrity of the dam is a significant local issue, it does not have a direct bearing on watershed management for the protection and quality of Glenmere Lake.

1.4 Existing Data, Mapping, and Reports

Data, mapping, and information have been gathered from a variety of sources related to the lake, its watershed, the water supply, and the dam. A summary of documents gathered is indicated below.

General Watershed Materials

1. Beamont, J., and O'Brien, D., 2005. Impervious Cover, Road Density, Land Use, and Population Density in Urban and Rural Areas in Orange County and Rockland County, New York. Prepared for Orange County Water Authority. October 2005.

2. Bugliosi, E.F., G.D. Casey, and D. Ramelot, 1998. Geohydrology and Water Quality of the Wallkill River Valley Near Middletown, New York. USGS Open-File Report 97-241.

3. Esposito & Associates, 2010. Figure No. 1-3: Glenmere Preserve Limits of Disturbance. Goshen, New York. March 2010.

4. Moran, Elizabeth C., 2009. Chemical Treatment of Cazenovia Lake: Permitting Challenges and Lessons Learned. Prepared for Cazenovia Lake Association, Inc.

5. New York State Department of Environmental Conservation, 2008, The Lower Hudson River Basin Waterbody Inventory and Priority Waterbodies List.

6. New York Times, 1902, Elliot S. Weeden Drowned.

7. Orange County Soil and Water Conservation District. *Wallkill River Watershed Conservation and Management Plan.* Prepared in cooperation with Ulster County Soil and Water Conservation District, Orange County Planning Department, Orange County Water Authority, Ulster County Planning Department. Funded in part by grant from New York State Department of Environmental Conservation's Hudson River Estuary Program. Date unknown.

8. Orange County Water Authority, 2008. Water Quality Biomonitoring Project Summary Report for Years 2004-2006. Goshen, New York. February, 2008.

9. Schneider, R., 2007. Glenmere Lake Watershed Summary of Management Issues. Prepared for Orange county Water Authority. 28 November, 2007.

Water Supply Related Materials

10. New York State Commissioner of Health, 1921, Rules and Regulations for the Protection from Contamination of the Public Water Supply of the Village of Florida, Orange County.

11. New York State Department of Health, Part 5, Subpart 5-1, Public Water Systems: Water Quality Monitoring Tables.

12. New York State Department of Health, 2005, Source Water Assessment Report for the Village of Florida Water Supply.

13. Orange County Department of Planning, Orange County Water Authority and HDR Architecture and Engineering, Water Master Plan: Ammendment to Orange County Comprehensive Plan. August, 2010

14. Orange County Water Authority, 2000. Correspondence Regarding Glenmere/Greenwood Lake Safe Yield Analysis Correspondence between Village of Florida Water Department and Orange County Water Authority regarding Village of Florida Water Supply Permit. 20 July 2000.

15. Orange County Water Authority, 1993. Glenmere Lake Safe Yield Analysis. Goshen, New York. April, 1993.

16. Village of Florida Water Department, 1998. Water Conservation Program Form. In support of New York State Public Water Supply Permit (ECL 15-1501).

17. Village of Florida Water Department, 2010, Annual Drinking Water Quality Report for 2010.

18. Village of Florida Water Department, 2009, Annual Drinking Water Quality Report for 2009.

Dam-Related Materials

19. Tectonic Engineering Consultants, P.C., 1993. Phase 1 Study Rehabilitation of Glenmere Lake Dam. Prepared for Orange County Department of Public Works. Highland Mills, New York. April, 1993.

Ecological Materials

20. Allied Biological, 2007, Glenmere Lake Northern Cricket Frog Survey.

21. [Author Unknown], 2009, "Confidential Observations of Glenmere Lake and nearby Uplands."

22. Barbour, J.G., date not listed. Ecological Issues of Glenmere Lake. Prepared for Glenmere Conservation Coalition, Sugar Loaf, New York.

23. Micancin, J., University of North Carolina Department of Biology, 2008, Letter to NYSDEC regarding Northern Cricket Frog.

24. NYSDEC, 1993, Northern Cricket Frog field report.

25. NYSDEC, 1994, Northern Cricket Frog field report.

26. Zappalorti Sr., R., and Zappalorti Jr., R, 2008. Results of a Northern Cricket Frog Drift Fence Survey at Glenmere Lake, Orange County, New York. Prepared for Dvirka and Bartilucci Consulting Engineers, Woodbury, New York. 8 October, 2008.

Brownfield-Related Materials

27. Dvirka and Bartilucci, 2011, Site Investigation/Remedial Alternatives Report for Glenmere Lake Property, Orange County, New York, NYSDEC ERP Site No. E3-36-071, prepared for Orange County Department of Parks, Recreation, and Conservation.

28. New York State Department of Environmental Conservation, 2011. Fact Sheet: Remedy Proposed for Municipal Brownfield Site; Public Comment Period and Public Meeting Announced. NYSDEC Environmental Restoration Program. Albany, New York.

29. "Record of Decision – Glenmere Lake Property Environmental Restoration Project – Chester, Orange County – Site No. E336071, March 2011" prepared by the Division of Environmental Remediation, New York State Department of Environmental Conservation.

30. Johnson, E., 2011. Toxic buildings pose danger to Glenmere Lake. The Chronicle. Vol 12, No. 9. 4 March, 2011.

1.5 Connection to Other Planning Efforts

The Orange County Soil and Water Conservation District developed and published the Wallkill River Watershed Conservation and Management Plan in 2005. The plan was prepared in cooperation with the Ulster County Soil and Water Conservation District, the Ulster County Planning Department, the Orange County Planning Department, and the Orange County Water Authority.

Although the Wallkill River Watershed Conservation and Management Plan does not *directly* address or mention Glenmere Lake, the Glenmere Lake watershed is included in the plan because Glenmere Lake and its watershed are within the Wallkill River watershed. The plan does, however, address issues along Quaker Creek. Quaker Creek is located downstream of Glenmere Lake. The lake and its outflow stream (Browns Creek) are tributaries to Quaker Creek.

The Wallkill River Watershed Conservation and Management Plan notes that the Quaker Creek subwatershed was 23% "developed" in 1993 and 30% developed in 2004. The plan notes that the Wildlife Conservation Society has identified high quality habitat throughout the subwatershed in its Southern Wallkill Biodiversity Plan. "Species of concern" were listed in the watershed plan and include the Eastern box turtle, five-lined skink, spotted turtle, longtail salamander, Northern cricket frog, wood frog, Upland sandpiper, Indiana bat, and falcate orangetip butterfly.[2] The watershed plan lists Quaker Creek as a watercourse that should be prioritized for public access.

As watershed initiatives are implemented over the coming years, it will be important to ensure that the goals of the subject plan are aligned with the goals of the Wallkill River Watershed Conservation and Management Plan.

[2] The Wallkill River Watershed Conservation and Management Plan should be reviewed for additional detail.

2.0 EXISTING CONDITIONS

2.1 Introduction

A basic understanding of a watershed is an essential beginning to developing a sound management plan. The limit of the Glenmere watershed, along with a factual accounting of what is happening within its boundaries, is provided in this section. The information contained in the following sections is based on published documents, information provided by Advisory Committee members, and direct observations by MMI.

Figure 2-1 shows the location of Glenmere Lake within the southwest corner of Orange County. Figure 2-2 shows the boundary of the watershed, which is located mostly in the town of Warwick, with small portions in the town of Chester and village of Florida.

2.2 Municipal Composition

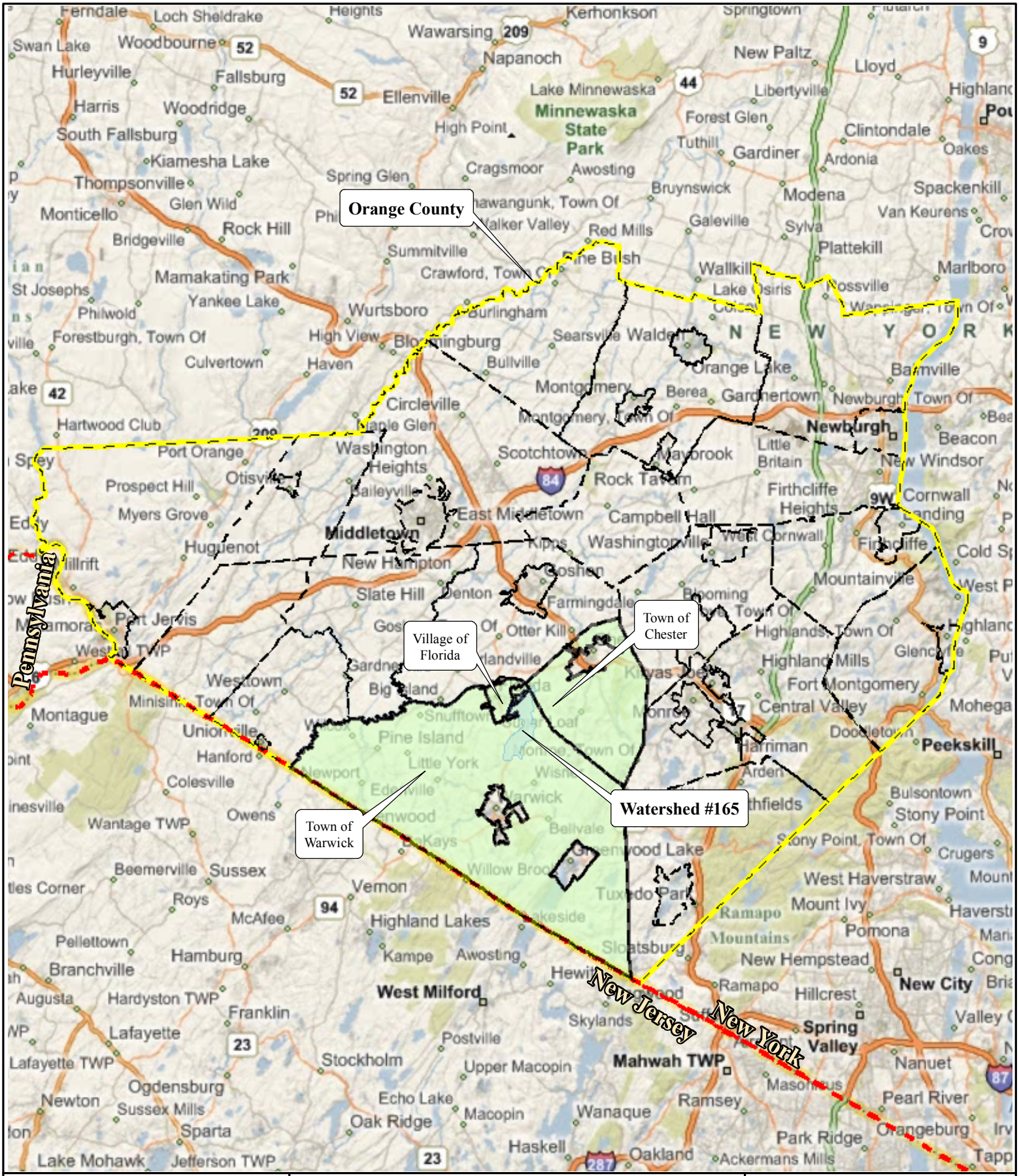
The whole of Glenmere Lake and its contributing watershed lie within Orange County, New York. The lake is physically located within the towns of Warwick and Chester, as well as the village of Florida.

Town of Warwick

The Town of Warwick was formed by act of the State Legislature on March 7, 1788. The town was initially divided into three districts: western, middle, and eastern. For each district, an assessor, a commissioner of roads, a collector, and two fence viewers were selected. The town of Warwick retained its original boundaries until 1845, when the northeast corner was cut off to become a portion of the newly formed town of Chester. The town of Warwick is the largest town in Orange County with regard to area and is one of the largest towns in area in New York State.

Several hamlets were in existence before the town was formed. The community of Florida was also established by the middle of the 1700s. During the 1800s, Amity, Edenville, and Pine Island became centers of population in the midst of the surrounding dairy, fruit, and vegetable farms. Iron mining, charcoal burning, and lumbering were occupations of settlers in the mountains from Sterling to Cascade; quarrying provided work near Mount Adam and Mount Eve. Greenwood Lake became well known to hunters and fishermen and evolved into a popular resort and recreation area.

There are now three incorporated villages within the boundaries of the town of Warwick. These are Warwick (incorporated in 1867), Greenwood Lake (incorporated in 1924), and Florida (incorporated in 1946).



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Location Map

LOCATION:
Orange Country, NY

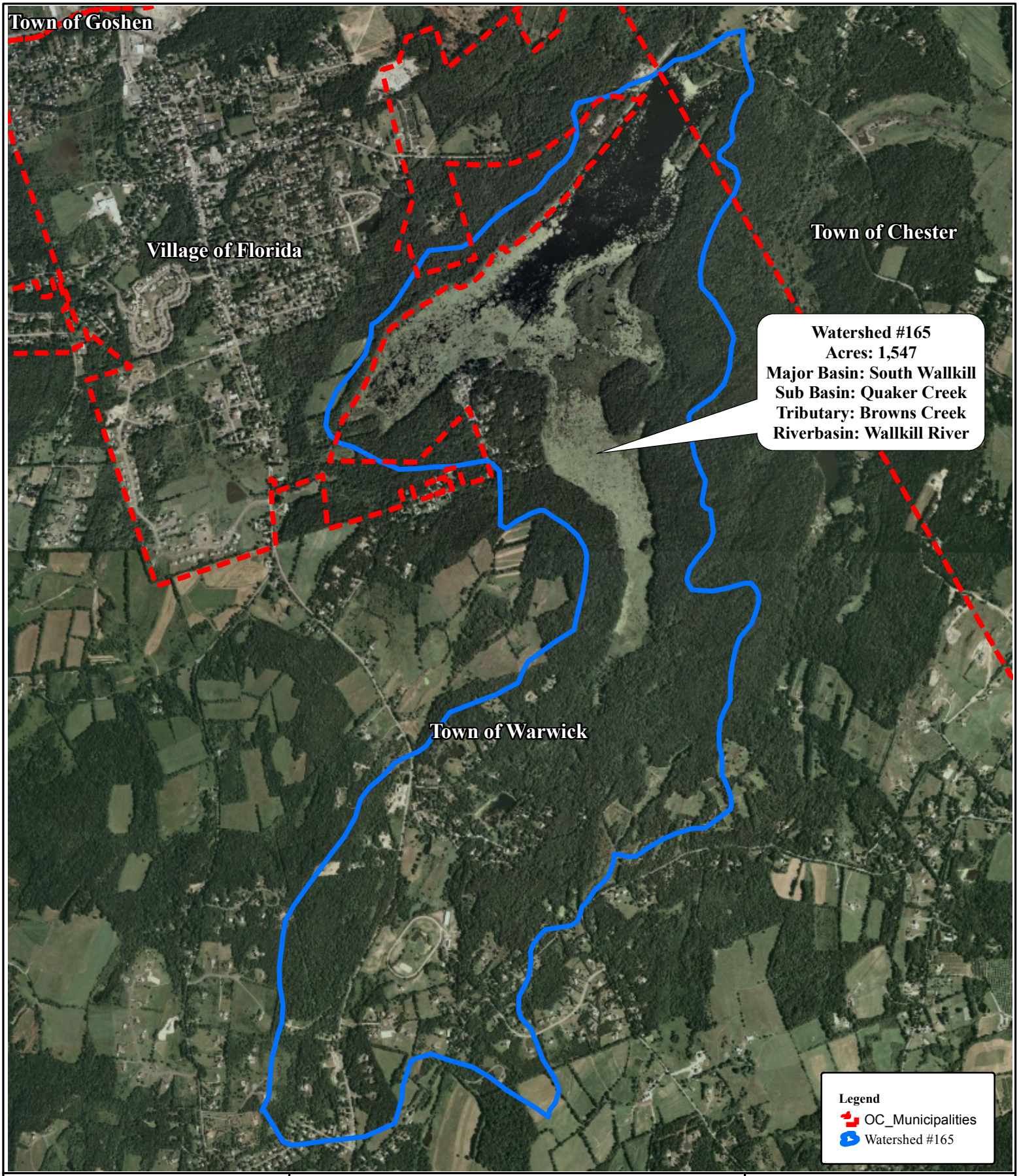
MMI#: 4515-01
MXD: P:\state_scale_loc.mxd
SOURCE: CT DEP, NYS GIS, NJ DEEP GIS, Orange County GIS, Microsoft Virtual Earth

N

Glenmere Lake Watershed Assessment & Management Action Plan

Map By: SMG
Date: April, 2011
Scale: 1" = 30,000'

SHEET:
Figure 2-1



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Watershed Boundary

LOCATION:
Orange County, NY

MMI#: 4515-01
MXD: P:\H2Oshed_Boundary.mxd
SOURCE: Orange County GIS Division, Microsoft Virtual Earth

N

Glenmere Lake Watershed Assessment & Management Action Plan

Map By: SMG
Date: April 2011
Scale: 1" = 2,000'

SHEET:
Figure 2-2

The Town Supervisor functions as the chief executive of the Town of Warwick. The Supervisor is in charge of all town offices and has broad administrative responsibility for the town budget. The Supervisor presides over the Town Board and has equal vote with the other Town Board members.

The Planning Board studies and votes on applications for site plan review, special use permits, and subdivisions; participates in official map changes and zone changes; and develops, adopts, and modifies the zoning ordinance, zoning map, and Comprehensive Plan. This independent board is appointed by the Town Board. The Comprehensive Plan Review Board is appointed and activated as needed to assist with revisions to the Comprehensive Plan. The Planning Department houses the staff assigned to issues of interest to the Planning Board.

The Town of Warwick Department of Public Works (DPW) was formed in 1986 when the responsibilities of the Town Highway Department and Town Park Department were combined. The DPW is responsible for maintenance and improvements to the town road system and parks. This includes repairing the local highways and removing snow.

The Building Department enforces New York State and Town of Warwick Building Code Requirements in a manner to ensure the safety and stability of all structures within the town. The Building Department issues any relevant permits, and the building inspector, town engineer, and code enforcement personnel review the work.

As the town with the largest portion of the Glenmere Lake watershed within its boundaries, the Warwick Planning Board, Department of Public Works, and to a lesser extent the Building Department have the potential to possess great influence on land use and infrastructure management in the watershed.

Several other town boards and agencies are important to watershed management. These include the Agricultural Advisory Board /Agriculture and Open Space Preservation Board, Open Space Ordinance Committee, Conservation Board, Purchase of Development Rights (PDR) Evaluation Committee and Advisory Committee, Recreation Commission, Zoning Board of Appeals, and Community Preservation Fund Advisory Board. Several of these agencies are directly involved with matters of open space management, conservation, and community preservation.

As one of the most populous municipalities in the county, the town of Warwick has grown along with the county. The 2010 census revealed a townwide population of 32,065, representing an increase of 4% from the 2000 population of 30,764. Additional growth is anticipated in the coming years.

Town of Chester

As discussed above, the Town of Chester was formed in 1845 when the northeast corner of the town of Warwick was cut off to become a portion of Chester. Parts of the towns of Blooming Grove, Goshen, and Monroe were also organized into Chester. The town includes one incorporated village, also called Chester. Agriculture has historically been an important land use in the town and remains as such to this day.

Similar to the Town of Warwick, the Chester Town Supervisor functions as the chief executive of the town. The Supervisor is in charge of all town offices and has broad administrative responsibility for the town budget. The Supervisor presides over the Town Board and has equal vote with the other Town Board members.

This Planning Board is appointed by the Town Board and has duties that are similar to the Planning Board in Warwick with regard to zoning, site plan reviews, subdivision approvals, and development of the Comprehensive Plan. Key municipal departments and agencies relative to watershed management include the Highway Department, Building Department, Engineering Department, Parks and Recreation Commission, and Zoning Board of Appeals. While these departments and agencies may have responsibilities that are germane to watershed management, it is recognized that the town of Chester has only a small portion of the Glenmere Lake watershed within its boundaries, and only a segment of one roadway is located within this area.

The town of Chester has not grown at the same pace as the county. The 2010 census revealed a townwide population of 11,981, representing a decrease from the 2000 population of 12,140. However, growth is anticipated in the coming years.

Village of Florida

The Village of Florida was incorporated in 1946 from the Town of Warwick. While it is an important population center straddling two towns (Warwick and Goshen), the village is also known for its agricultural history.

The Village Board, Planning Board, and Zoning Board of Appeals are the three agencies of the village. The Village Board is the chief governing board. The Planning Board is responsible for directing orderly growth within the community in accordance with the zoning laws. The village has only a few municipal departments: Building and Planning, Department of Public Works, Parks and Recreation, the Police Department, the Village Offices (Village Clerk), and the Water Department. Similar to the town of Chester, only small portions of the village are located within the boundaries of the Glenmere Lake watershed.

The village of Florida has grown along with the county. The 2010 census revealed a population of 2,833, representing an increase of 10% from the 2000 population of 2,571. Additional growth is anticipated in the coming years.

2.3 Land Cover and Land Use Within the Watershed

The Glenmere Lake watershed is not densely developed; however, it does support a mix of residential and small pockets of commercial and agricultural uses along with large areas of undeveloped open space.

The county maintains a significant land holding within the watershed and a large part of the lake proper. The Village of Florida does not own a significant land area but has water rights to use the upper portion of the water column for drinking water supply, which is withdrawn at the northern end of the lake, where it is treated at the water filtration plant on Glenmere Avenue Extension.

The most concentrated residential development within the watershed occurs within a portion of Glenmere Homesites, located within the town of Warwick adjacent to the lake, including all or portions of the following streets: Orange Road, Goshen Road, Noble Place, Warwick Place, Funnel Place, Roe Place, Tweed Place, Pine Road, Florida Road, and Oak Road. A portion of State Route 94 lies within the watershed near its intersection with Miniturn Road in the town of Warwick to its intersection with Claire Ann Drive in the upper watershed.

The upper watershed includes Miniturn Road, West Lake Road, Parnell Drive, Ranieri Place, Lower Hillman Road, Upper Hillman Road, Mona Lisa Lane, a portion of East Ridge Road, Horse Hill Lane, Claire Ann Drive, and a small number of side spur roads.

Many water supply reservoirs are completely closed to the public, with no recreation allowed. Glenmere Lake provides a variety of recreational opportunities although not unrestricted use of the lake. The county owns large tracts of land around the lake, but this land is not available to the public for recreational purposes. The northwestern portion of the lake near the dam and water treatment building are fenced off and not accessible.

The Village of Florida's Park at Glenmere Lake is located on the western shoreline just south of the treatment facility and is largely used for picnicking and passive recreation. Park rules and restrictions, including no swimming and pet management, are designed to mitigate any negative effects on lake water quality due to activities at the park. The park rules and regulations are as follows:

- Cars are allowed on the roadway and parking lot only. Parking on the roadway and overnight parking are not permitted. No vehicles, boats, or trailers are allowed to park between the road and shoreline except at designated areas.
- No alcoholic beverages are permitted.
- Glass bottles are prohibited.
- Please deposit all trash in the receptacles provided.
- Dogs must be leashed at all times, and owners must pick up after them.
- No all terrain vehicles are permitted in the park.
- No snowmobiles are permitted in the park.

- No swimming.
- No gas motors are allowed on or near the reservoir.
- No tents, camping, campfires, bonfires, or cook fires are permitted without special Village of Florida permits.
- A reservation fee and an approved permit are required for use of the Hansen Pavilion.
- Any abuse of the park or failure to comply with all regulations will result in the revocation of all park privileges.

Local residents report that the lake has historically been an excellent fishery resource, primarily by boat, but that the proliferation of rooted vegetation has significantly hindered fishing in recent years. Smallmouth bass and pickerel are reported to be the most popular fisheries. Other recreational activities that are reported on or near the lake include kayaking and bird hunting, walking, picnicking, and various forms of passive recreation.

2.4 Hydrology

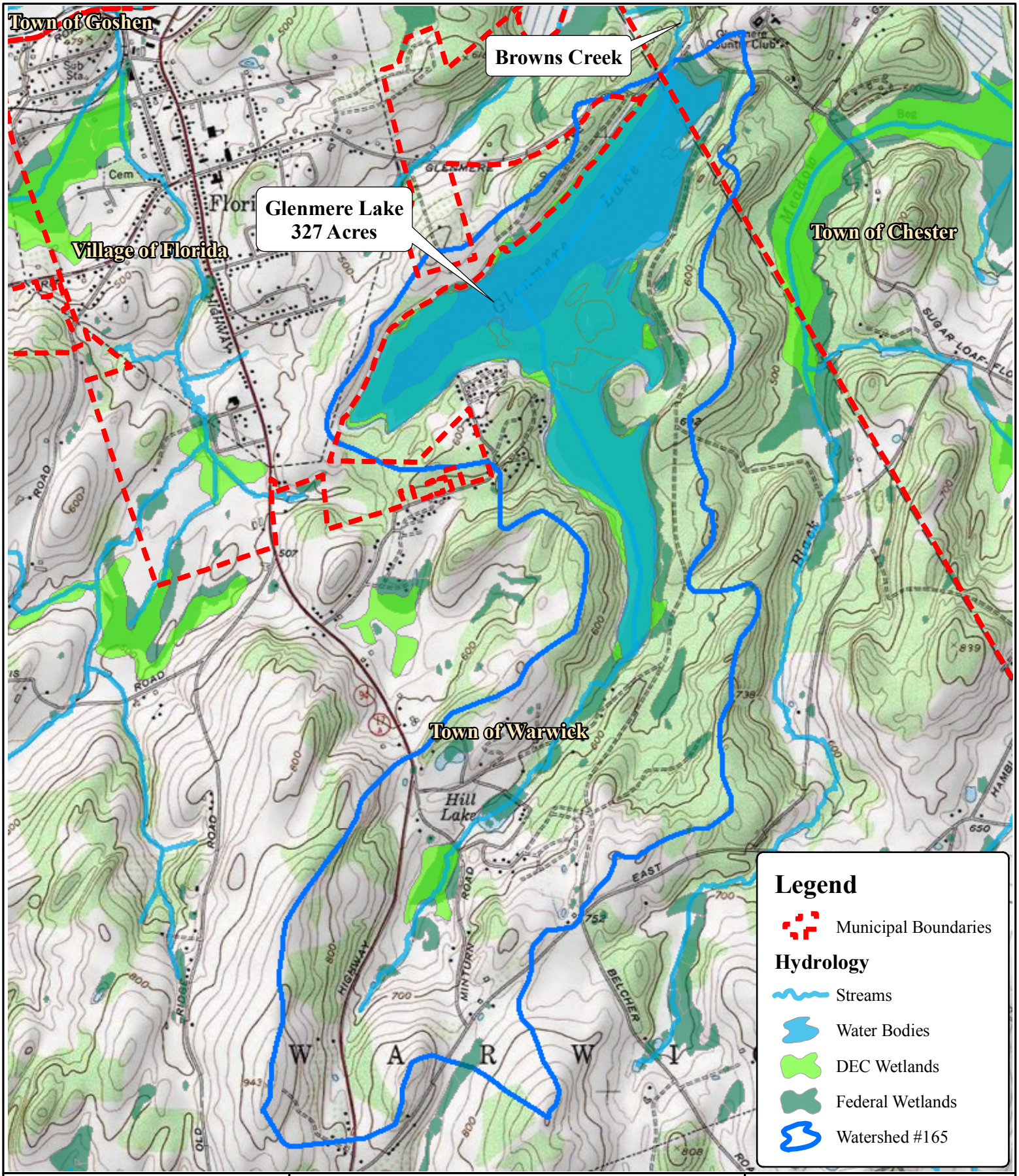
The term watershed refers to the area surrounded by high spots, or divides, from which water drains or flows downhill to or past the point in question (Leopold, 1997). Surface water movement through a watershed begins with runoff flowing downhill as sheet flow, collection in small rivulets that erode shallow channels in the soil, and joining of small streams (MacBroom, 1998). These small streams receive additional runoff downstream and ground water discharge from locally infiltrated precipitation, eventually merging where valleys meet.

The Glenmere Lake watershed (EPA Hydrologic Unit Code 165) is approximately 2.5 square miles in size and is an indirect drainage to the Wallkill River. Glenmere Lake covers approximately 327 acres of its watershed with open water in the northern half of the watershed. The inflow to the lake is unnamed on the United States Geological Survey (USGS) topographic map but is known locally as either Browns Creek or Witch Hollow Creek[3]. The outflow from the lake is formally named Browns Creek and depicted as such on the USGS topographic map. Browns Creek flows into Quaker Creek, which in turn flows into the Wallkill River. The Wallkill River flows north through Walden, Wallkill, and New Paltz before converging with the Rondout Creek near Rosendale and then draining into the Hudson River in Kingston, New York.

The highest elevation in the Glenmere Lake watershed is approximately 940 feet on a peak located west of the intersection of State Route 94 and East Ridge Road. The lowest elevation in the watershed is the surface at the Glenmere Lake at approximately 532 feet (depending on drinking water demand and use of flashboards). The average slope of the watershed upstream of the lake is 4.5%.

Figure 2-3 shows the hydrologic features of the watershed. Figure 2-4 shows the Federal Emergency Management Agency (FEMA) mapped flood zones within the watershed.

[3] This report uses "Browns Creek" for the inlet stream as well as the outlet stream from Glenmere Lake.



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Watershed Hydrology

LOCATION: Orange County, NY

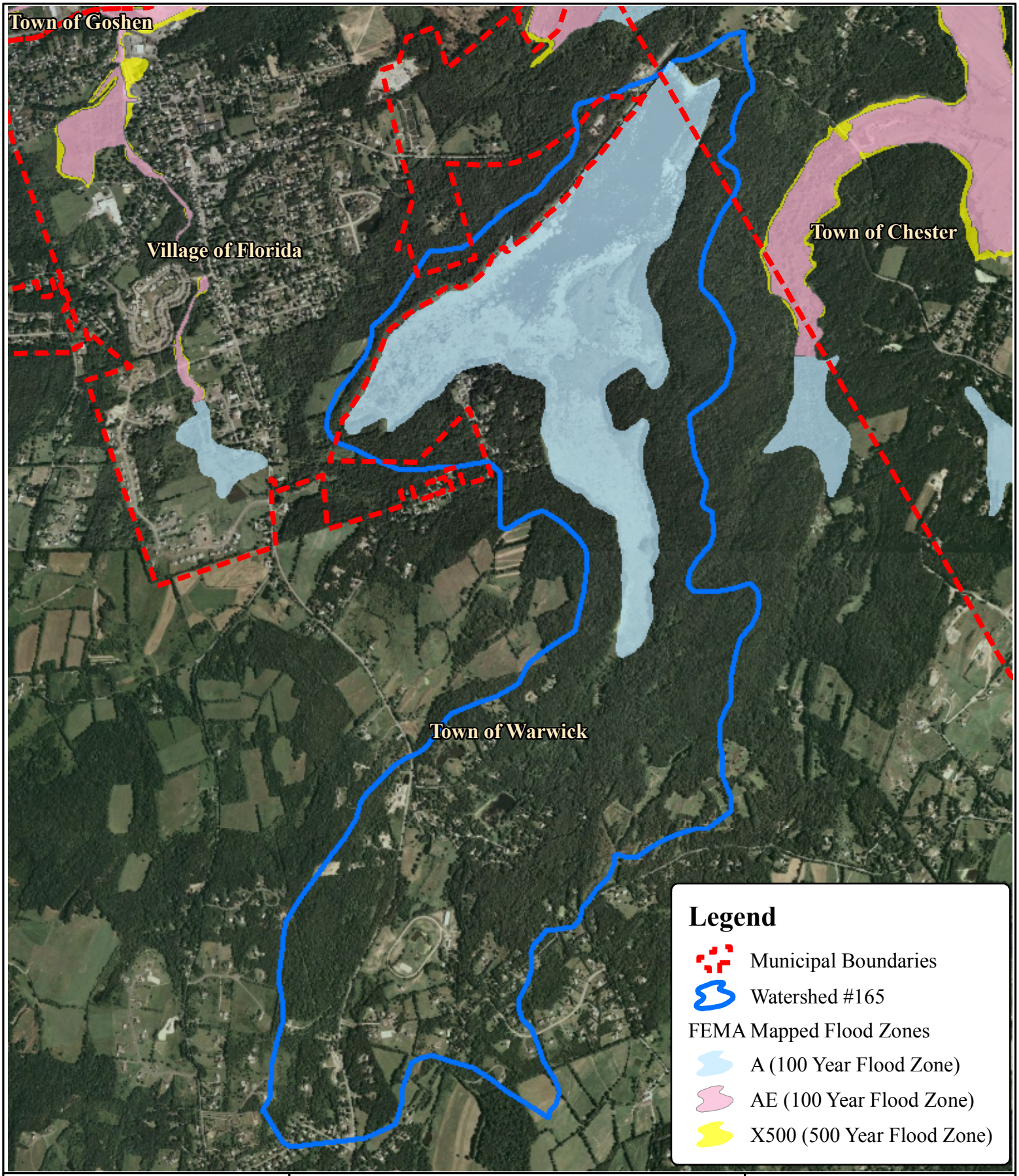
MMI#: 4515-01
MXD: P:\Hydrology_topo.mxd
SOURCE: Orange County GIS Division, Microsoft Virtual Earth

N

Glenmere Lake Watershed Assessment & Management Action Plan

Map By: SMG
Date: April 2011
Scale: 1" = 2,000'

SHEET: Figure 2-3



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FEMA Mapped Flood Zones

LOCATION: Orange County, NY

MMI#: 4515-01
MXD: P:\FEMA.mxd
SOURCE: Orange County GIS Division, Microsoft Virtual Earth

N

Glenmere Lake Watershed Assessment & Management Action Plan

Map By: SMG
Date: April 2011
Scale: 1" = 2,000'

SHEET: Figure 2-4

The lake is designated an unnumbered A-zone, meaning it lies within the 100-year flood zone but has not been studied by FEMA using detailed methods. There are no other designated 100-year floodplains within the watershed outside of the lake itself and no known flooding issues.

Browns Creek is not gauged by the USGS and, therefore, its rate of discharge or flow is unknown at any given time. Peak flows can be estimated using the USGS' *StreamStats* program (http://water.usgs.gov/osw/streamstats/new_york.html) although it is important to note that the small watershed size of 0.98 square miles (measured where the creek enters Glenmere Lake) falls below the range of areas for which the *StreamStats* program is best suited. Estimated peak flows are as follows:

TABLE 2-1
Estimated Peak Flows of Browns Creek at the Glenmere Lake Inlet

Flow Event	Flow (cfs)	Flow Event	Flow (cfs)
1.25-year discharge	34	25-year discharge	183
1.5-year discharge	43	50-year discharge	227
2-year discharge	56	100-year discharge	277
5-year discharge	97	200-year discharge	332
10-year discharge	131	500-year discharge	416

cfs = cubic feet per second

StreamStats is not equipped to estimate statistical low flows in the state of New York. The current publication of record for estimating low streamflows is USGS Water-Resources Investigations Report 85-4070, *Method for Estimating Low-Flow Statistics for Ungaged Streams in the Lower Hudson River Basin, New York*. The report presents regression equations for calculating the 7Q10 and 7Q2 flows[4] of streams in the Lower Hudson River Basin. Of the 53 gauged streams used for the regression analysis, two were located near Glenmere Lake. These are Wawayanda Creek (USGS site 1368810, with a watershed area of 44.96 square miles) and Stony Creek (USGS site 1369650, with a watershed area of 2.62 square miles). Of the two, Stony Creek is most similar in size and watershed composition when compared to Browns Creek.

According to the report, the observed 7Q10 flow for Stony Creek was 0.02 cubic feet per second (cfs) whereas the observed 7Q2 flow was 0.08 cfs. Although both instream flows are very low, consistent with the small watershed size, the regression equations predicted negligible flow conditions for the 7Q10 flow and 0.02 cfs for the 7Q2 flow. Given the poor fit to the regression equations and in light of the close proximity of Stony Creek to Browns Creek, a more appropriate means of estimating the 7Q10 and 7Q2 flows of Browns Creek is to perform a direct watershed transform. Based on the ratio of watersheds of the two watercourses, the estimated 7Q10 and 7Q2 flows for Browns Creek

[4] The 7Q10 flow is the seven-day discharge that occurs with a 10-year recurrence interval. The 7Q2 flow is the seven-day discharge that occurs with a two-year recurrence interval. Both are considered statistical low flows.

at the Glenmere Lake inlet are 0.007 cfs and 0.029 cfs, respectively. These are equivalent to approximately 4,500 gallons per day (gpd) and 18,700 gpd, respectively.

2.5 Geology

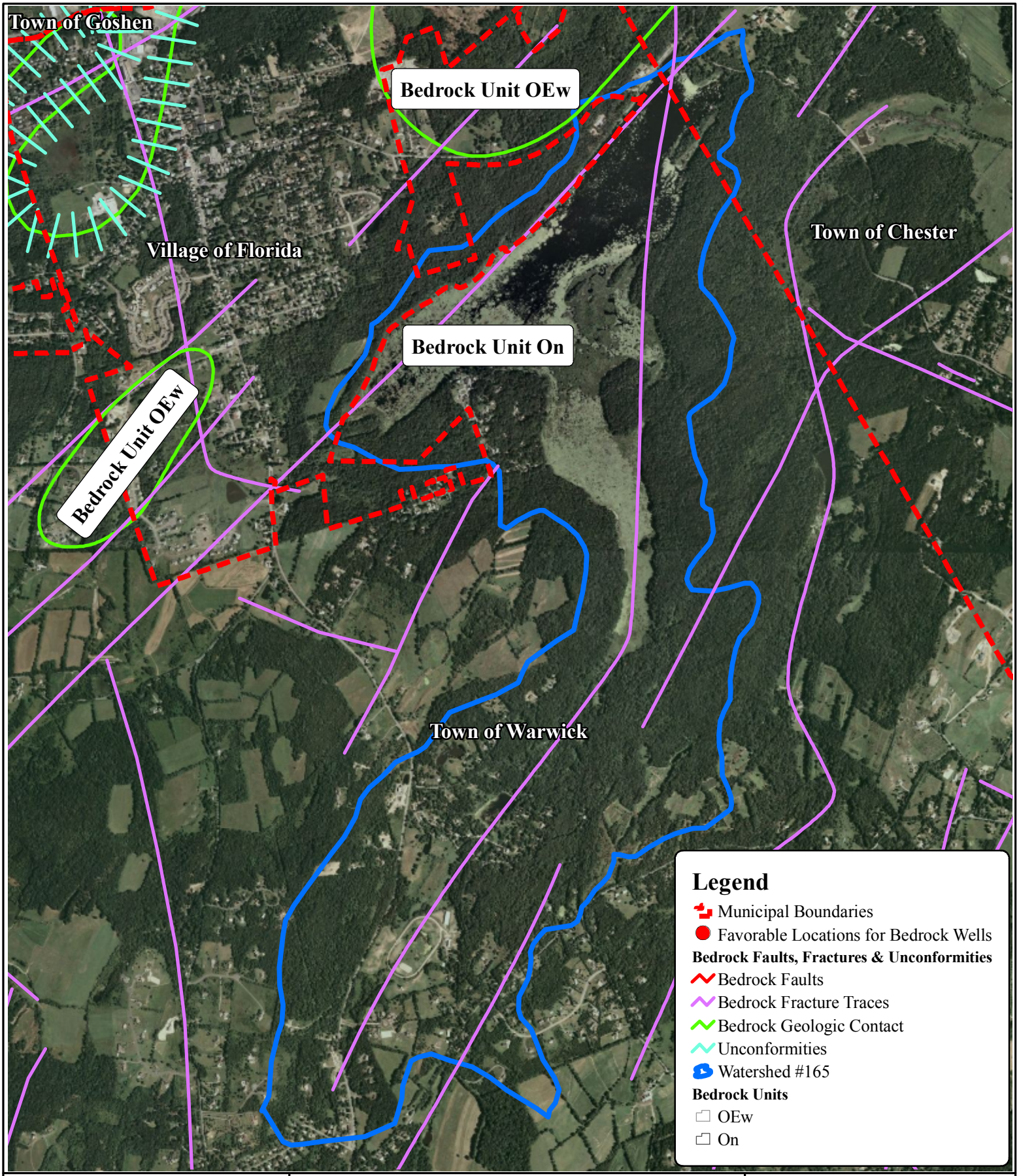
The geologic history of a region provides the land forms upon which drainage patterns and watersheds are established and subsequently evolve. Likewise, the type of bedrock and surficial materials present dictate land form, stream characteristics, lake formation, and background water quality in these surface water features.

Figure 2-5 shows the bedrock fracture traces within the Glenmere Lake watershed as well as the aerial extent of the bedrock faults and fractures within the watershed. According to the regional Water Master Plan (HDR 2009), most of the bedrock underlying Orange County is highly fractured sandstone and mudstone. The watershed is underlain by the Martinsburg Formation. This formation consists of shale, graywacke, sandstone, and siltstone. Bedrock fracture traces have been mapped in the area and are depicted on Figure 2-5. Note that the fracture traces are aligned with the watershed lengthwise as well as the two arms of Glenmere Lake. This implies that bedrock structure influences hydrology and topography in the watershed.

Figure 2-6 depicts the surficial soil types in the Glenmere Lake watershed. Table 2-2 presents aerial extent, percent coverage, and a brief description of the soil types in the watershed.

TABLE 2-2
Soil Coverage in the Glenmere Lake Watershed

Soil Type	*Description*	*Aerial Extent (acres)*	*Percent Land Coverage in Watershed*
Alden	Hydric soil; silts, clays, and very fine sands that pond; nearly level	681	17
Bath-Nassau	Mesic soil; medium sands and silts with bedrock and surface stones; nearly level to through sloping	752	19
Erie	Hydric soil; silts, clays, and very fine sands that are wet; nearly level to sloping	560	14
Histic Humquets	Hydric soil; waterbodies and marshland	591	15
Mardin	Mesic soil; sands and silts that are influenced by steep slopes; moderately steep to steep (over 15%)	618	15
Rock-Nassau	Silts influenced by bedrock; nearly level to sloping	800	20



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Bedrock Geology

LOCATION: Orange County, NY

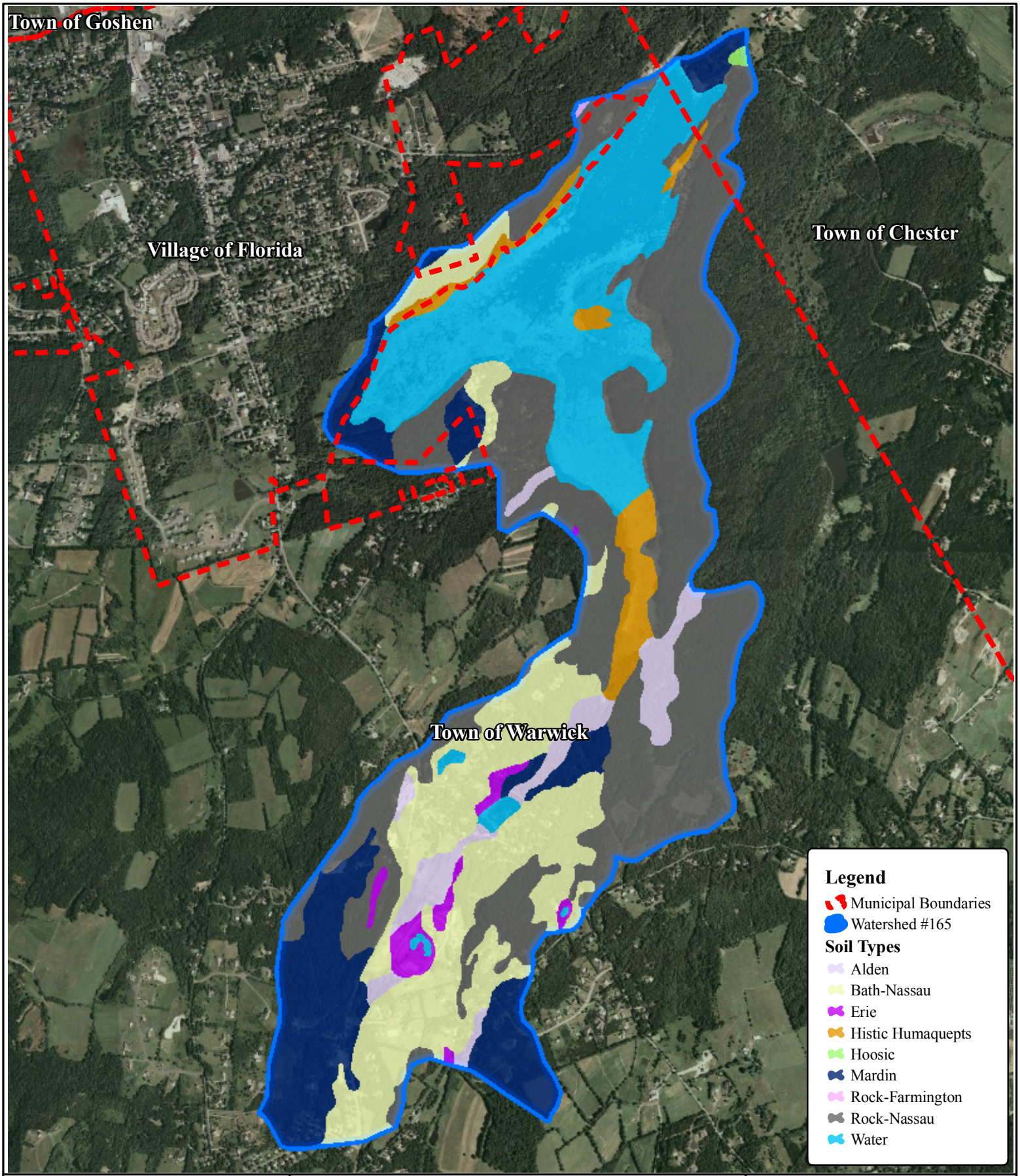
MMI#: 4515-01
MXD: P:\Bedrock.mxd
SOURCE: Orange County GIS Division, Microsoft Virtual Earth

N

Glenmere Lake Watershed Assessment & Management Action Plan

Map By: SMG
Date: April 2011
Scale: 1" = 2,000'

SHEET: Figure 2-5



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Soil Types

LOCATION: Orange County, NY

MMI#: 4515-01
MXD: P:\Soils.mxd
SOURCE: Orange County GIS Division, Microsoft Virtual Earth

N

Glenmere Lake Watershed Assessment & Management Action Plan

Map By: SMG
Date: April 2011
Scale: 1" = 2,000'

SHEET: Figure 2-6

2.6 Wetlands

Figure 2-7 depicts the wetland areas classified by both the United States Fish & Wildlife Service (USFWS) and the NYSDEC. Table 2-3 shows the aerial extent and percent coverage of these wetlands in the watershed.

TABLE 2-3
Wetland Areas in the Glenmere Lake Watershed

Wetland Classification	Aerial Extent (acres)	Percent Land Coverage in Watershed
State Wetlands (NYSDEC)	228	15
Federal Wetlands (USFWS)	306	20

The wetlands surrounding Glenmere Lake are important biological communities because they help support a state endangered species, the Northern cricket frog, described in Section 2.8. Wetlands are generally important watershed features because they provide valuable ecological habitat, they purify water, and they act as water storage areas.

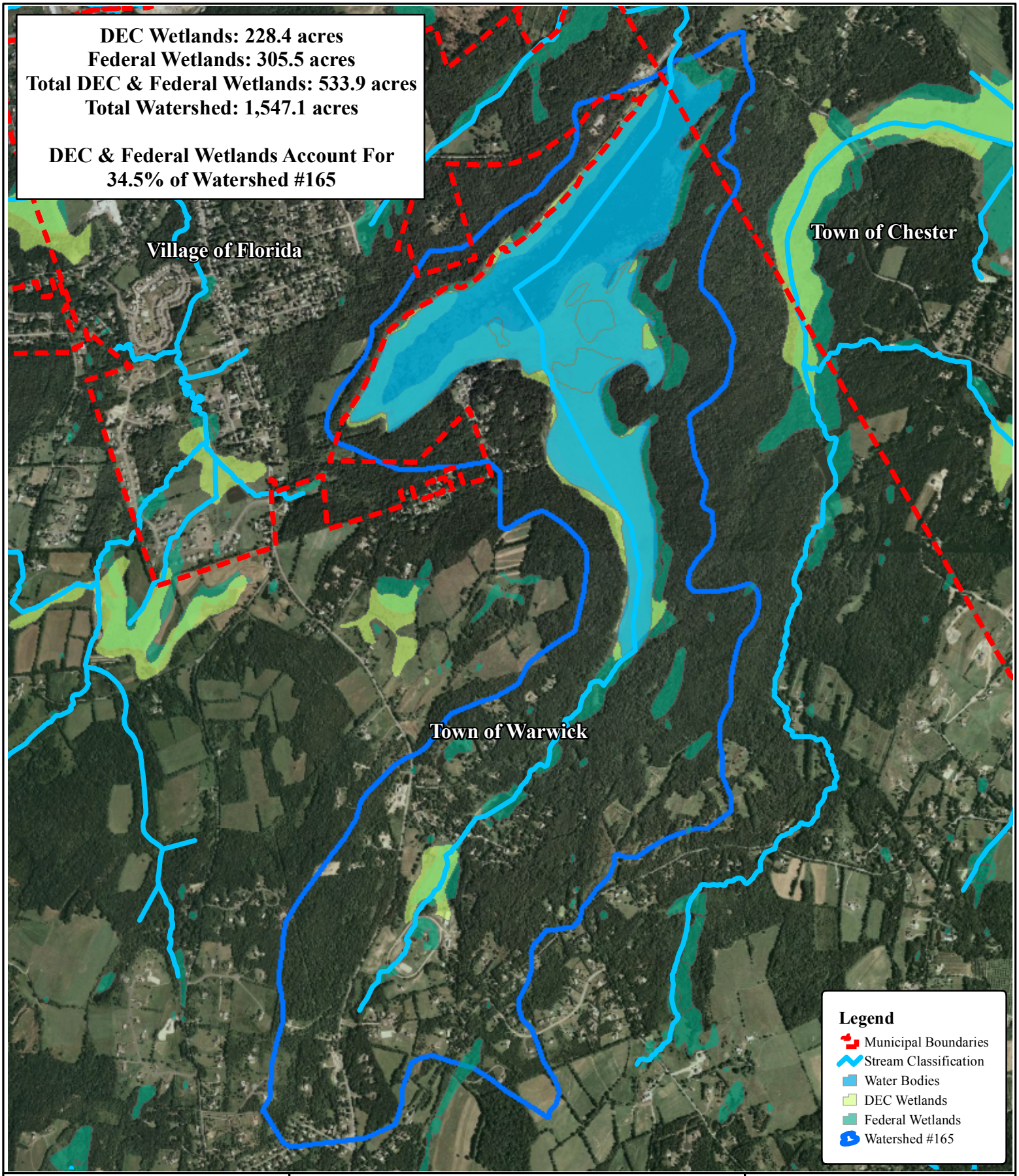
2.7 Aquatic Vegetation

Historic Field Studies

The abundance and types of aquatic vegetation in Glenmere Lake have been documented over the years. One of the earliest references to aquatic vegetation in Glenmere Lake is a short news brief from the *New York Times* published in 1902 subsequent to the drowning of a local boy ("Boy Falls Out of Boat While Washing Lilies in Glenmere Lake"). This news brief documents that lilies were present in the lake at that time.

Northern cricket frog surveys and related surveys conducted by NYSDEC began documenting vegetation in the lake in the 1990s. The field sheet from a botanical survey in 1993 indicates that Glenmere Lake was a "large eutrified lake with abundant submerged and floating vegetation; many mats and boggy islands." A survey conducted the next year indicated that "dominant plants include Nuphar luteum, Nymphaea odorata, Decodon verticillatus, Pontedaria cosdata, Cephalanthus accidentalis, Toxicodendron vernix, Drosera rotundifolia, Pogonia ophioglossoides; excellent water quality, wide diversity of vegetation with a great deal of structure." Decodon verticillatus in particular was cited in the 1994 notes as a potentially important species for Northern cricket frog protection from predation.

A NYSDEC rare animal survey conducted in 2004 reported similar findings: "large eutrophied lake with abundant submerged and floating vegetation, many mats and boggy islands. Dominant plants include Nuphar, Nymphaea, Decodon, Pontedaria, and Cephalanthus."



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Classified Wetland Areas

LOCATION: Orange County, NY

MMI#: 4515-01
MXD: P:\Hydrology.mxd
SOURCE: Orange County GIS Division, Microsoft Virtual Earth

N

Glenmere Lake Watershed Assessment & Management Action Plan

Map By: SMG
Date: April 2011
Scale: 1" = 2,000'

SHEET: Figure 2-7

Allied Biological, under contract to the Village of Florida, conducted a Northern cricket frog survey in 2007. The study described vegetation in terms of its suitability as frog habitat. Four study transects were conducted by Allied Biological. Comments related to vegetation were as follows:

- First transect –area of water treatment plant continuing to the park; little or no emergent aquatic vegetation; some Pickerelweed observed
- Second transect – park to southwest along western shoreline; emergent vegetation such as white water lilies
- Third transect – neck of south basin entrance; area was densely populated with both spatterdock (Nuphar variegata) and white water lily (Nymphaea odorata)
- Fourth transect – eastern shoreline north of the neck; very little emergent aquatic vegetation, though some lilies were present; at either end of this transect there were small islands and peninsulas with associated emergent aquatic vegetation

Allied Biological noted that the southern basin was not accessible by boat due to its dense vegetation. The report also noted that Eurasian water milfoil was present in the main basin of the lake.

Beginning in 2008, much of the correspondence related to Glenmere Lake resulted from the proposal to use the herbicide Sonar. In a *Times Herald-Record* article "Florida Considers Herbicide for Glenmere Lake" (2008), it was reported that DEC agreed to grant funds for applying Sonar to reduce Eurasian water milfoil.

A letter from biologist Jonathan Micancin (University of North Carolina Department of Biology) to NYSDEC in 2008 characterized Glenmere Lake as a "Large, old millpond covered by lily pads and other aquatic vegetation." While hypothesizing reasons for the Northern cricket frog population in the lake, the letter stated that "It is possible that a recent increase in aquatic vegetation at Glenmere Lake has allowed increased reproductive success and juvenile survival…." It is not apparent whether the phrase "recent increase in aquatic vegetation" was applicable to the entire lake or specific regions of the lake.

In 2009, an anonymous author observed submergent vegetation die-off while kayaking around the main body of Glenmere Lake. Potential reasons for the die-off were discussed in the author's one-page letter, but follow-up correspondence related to the reported die-off was not offered for the subject study.

J. G. Barbour prepared the report entitled "Ecological Issues of Glenmere Lake" subsequent to field reconnaissance conducted in 2010. According to Mr. Barbour, Glenmere Lake is a "circumneutral bog lake." The definition (provided by Hudsonia Ltd.) is "a spring-fed, calcareous water body that commonly supports vegetation of both acidic bogs and calcareous marshes. The lake is underlain by deep organic sediments; floating mats of vegetation and drifting peat rafts are often present. This is a rare habitat type in the region, known to support many rare species." It should be noted that a formal

designation of Glenmere Lake as a circumneutral bog lake has not been found in the literature although it may be somewhat "spring-fed" (in other words, ground water discharges to the lake), and it supports the vegetation described herein. The following seven characterizations are reprinted from the Barbour report:

- "The shallower portions of the lake south, east and northeast of the deep portion were the richest, including aquatic herbs and palustrine herbs, shrubs and trees. Deeper waters had pondweeds (Potamageton spp.), including P. epihydrus, P. illinoiensis, P. pusillus and P. zosteriformis. Other submergent plants included grassleaf mudplaintain (Heteranthera dubia), common coontail (Ceratophyllum demersum) and nodding water-nymph (Najas flexilis). Shallows near shore had Engelman's quillwort (Isoetes engelmani) and small waterwort (Elatine minima)."

- "Notable occurrences on palustrine islands and shores were roundleaf sundew (Drosera rotundifolia), northern pitcher plant (Sarasenia pupurascens), rose pogonia (Pogonia ophioglossoides), water willow (Decadon vericillata). Shrubs included hazel alder (Alnus serrulata), poison sumac (Toxicodendron vernix), silky dogwood (Cornus amomum) and buttonbush (Cephalanthus occidentalis). Floating-leaved aquatics included white water lily (Nymphaea odorata), yellow pond lily (Nuphar variegata), water shield (Brassenia schreberi), duckweed (Lemna minor) and watermeal (Wolffia spp.). Tall emergent herbs included cattails (Typha spp.), arrow arum (Peltandra virginica), pickerelweed (Pontederia cordata), bur-reeds (Sparganium spp.), rushes (Juncus spp.) and smartweeds (Polygonum robustius, P. amphibium, others)."

- "There was at the time of my visit no problem with water milfoil or any other plant species in any part of Glenmere Lake. This was well into the growing season with plants at near maximum coverage. There is certainly no current or pending threat or emergency from any invasive plant species. It is possible that observed levels of water milfoil represent maximum or near maximum potential abundance at Glenmere Lake, and will not increase significantly."

- "Eradication, even of only water milfoil, would not be effective long-term because water-milfoils are common and easily spread. Once eradicated from a body of water they would soon be back. A better long-term solution might be to introduce an herbivore that prefers Miriophyllum. The native milfoil weevil (Euhrychiopsis lecontei) is a specialist herbivore that prefers Eurasian water milfoil over native species (Solarz and Newman 1996). This weevil has proven an effective control in some locations."

- "I observed Eurasian water milfoil only in the deeper central area of the lake, along with native water milfoil (Miriophyllim heterophyllum), white water lily (Nymphaea odorata), water shield (Brassenia schreberi) and Illinois pondweed (Potamogeton illinoisensis). There were relatively few plants of these species, and all seemed to be stressed by the depth of the water, a great deal of energy apparently expended to grow

up to the available sunlight and the water surface. The condition of milfoils here was especially poor. Many plants were coated with what appeared to be decaying algae or decayed material of the plants themselves. New growth was minimal or absent, and few plants had grown sufficiently to reach the water surface, which they would need to do to bear flowers and fruit. The growing tips of about 90% of the milfoils were apparently dead or dying."

- "In the shallower remote areas of the lake, including the boggy areas, plants appeared healthier and more robust. Additionally, in the shallower areas of the lake there was a greater density and diversity of aquatic plants. This may be partly due to absence or low levels of copper sulfate, and the fact that shallower water is less stressful on bottom-rooted plants. The water was much clearer here as well, with sunlight reaching greater depths."

- "In these areas away from the deep center of the lake I did not find Eurasian water milfoil, but instead the similar-looking native coontail (Ceratophyllum demersum) and other plants that might be mistaken for Eurasian water milfoil. Nowhere in the lake did I see any indication of a current or potential problem with dominance or density of water milfoil. I consider it unlikely that a problem will develop with Eurasian water milfoil or any other invasive plant any time soon unless more invasives are introduced or other factors degrade water quality."

The Barbour report is the first to report specific locations of Eurasian water milfoil although it was observed only in the deeper central area of the lake.

A sediment sampling report completed by Tectonic Engineering & Surveying Consultants in 2010 is the most recent publication reviewed for this management plan that describes aquatic vegetation in Glenmere Lake. According to the report, the southern part of the lake is characterized by wetland vegetation including floating mats of purple loosestrife, alder trees, and cattails. The southwest portion of the lake has lily pads and algal growth. Dense aquatic vegetation was observed. Indeed, the intended sample locations #5 and #6 could not be accessed by boat due to the dense vegetation; these were in the southeast arm of the lake. Photographs were included in the report and document the presence of the vegetation cited.

A review of maps can sometimes be helpful in documenting the progression of vegetation in a lake but proved limited for this management plan. The three USGS topographic maps of the lake (Goshen Quadrangle, 1908; Warwick Quadrangle, 7.5-minute, 1957 and photo inspected in 1976; and Middletown Quadrangle, 30x60-minute, 1986) depict the lake as open water without any wetland symbols. However, it is known that vegetation was present during these dates based on the sources described above. An aerial photograph from 1975 shows emergent and possibly shrub/scrub vegetation in the southeast arm and the margins of the southwest arm of the lake. A recent aerial photograph (2009) shows emergent and shrub/scrub vegetation in both the southeast arm

and southwest arm.

In summary, submerged and floating aquatic vegetation have been present in Glenmere Lake since at least the beginning of the 20th century. Emergent aquatic vegetation has been present since at least the 1970s or earlier. Specific types of aquatic vegetation have been described since the early 1990s. Over the lifetime of the lake, the areal extent of aquatic vegetation has increased. The vast majority of these species are native. However, invasive Eurasian water milfoil has been observed.

Field Investigations by MMI

MMI conducted field investigations on June 8, 2011 and August 18, 2011. During this reconnaissance work, observations from the shoreline and from a canoe were made by Mr. Matthew Sanford, Professional Wetland Scientist (PWS). Wetland communities within the lake include palustrine open water, palustrine emergent, and palustrine scrub shrub. Palustrine forested wetlands are located along the periphery of Glenmere Lake. The following narrative describes the in-lake aquatic vegetation.

Palustrine Open Water

The palustrine open water areas can be typically subdivided into deep open water habitats (greater than 10 feet deep) and/or shallow open water habitats (less than 10 feet deep), with the latter being the most dominant habitat type within Glenmere lake. The deep open water habitats are primarily located along the northern portion of the lake where lake depths are approximately 11 feet. These deep-water habitats are relatively lacking in both floating aquatic vegetation (FAV) and/or submerged aquatic vegetation (SAV). The shallow open water habitats that are located throughout the lake consist of both FAV and SAV. FAV included yellow water lily (*Nuphar variegatum*), white water lily (*Nymphaea odorata*), water shield (*Brasenia schreberi),* and pondweeds including common pondweed (*Potamogeton epihydrus*). Density of FAV varies from sparse to patchy, to moderately dense, to heavy. Heavy densities of FAV occur along the southwestern and southeastern lobes and at the northern edge of the lake. The central portions of the lake are considered patchy to moderately dense with FAV.

Floating Aquatic Vegetation Southwestern Lobe

The SAV present within the lake during the June 2011 site visit included generalized water milfoil (*Myriophyllum* sp.), Naiad (*Najas flexilis*), coontail (*Ceratophyllum demersum*), and water crowfoot (*Ranunculus flabellaris*). The water milfoil dominated the central portions of the lake, with the other SAV species being found along the shoreline and southern lobes of the lake.

Floating Island of Emergent Vegetation

Palustrine Emergent Marsh

The palustrine emergent marsh wetlands are primarily found along the shorelines of the impoundment and are often intermixed with the palustrine scrub shrub wetlands. Floating islands of emergent marsh vegetation are also found within the southeastern lobe of the lake. Species observed within the emergent habitats included arrow arum (*Peltandra virginica*), pickerelweed (*Pontederia cordata*), duck potato (*Sagittaria latifolia*), mud plantain (*Alisma subcordata*), burreed (*Sparganium* sp.), marsh fern (*Thelypteris palustris)*, soft stem bulrush (*Schoenoplectus tabernaemontani)*, soft rush (*Juncus effusus*), narrow leaved cattail (*Typha angustifolia*), purple loosestrife (*Lythrum salicaria*), and water willow (*Decodon verticillatus*).

Palustrine Scrub Shrub

Palustrine scrub shrub wetlands are found along the shoreline of the lake and on floating vegetated islands within the southeastern lobe of the lake. Species observed within the scrub shrub habitats include buttonbush (*Cephalanthus occidentalis*), hazel alder (Alnus *serrulata*), poison sumac (*Toxicodendron vernix*), sweet pepperbush (*Clethra alnifolia*), highbush blueberry (*Vaccinium corymbosum*), and silky dogwood (*Cornus amomum*).

Scrub Shrub Vegetation Along Shoreline

Several grab samples of water milfoil were collected from the central areas of Glenmere Lake. Subsequent to the reconnaissance, samples of the milfoil were provided to the

Connecticut Agricultural Experiment Station (CAES) in New Haven, Connecticut and the firm Environmental Research and Consulting, Inc. (ERC) of Kennett Square, Pennsylvania. CAES reported that the sample appeared intermediate between the characteristics required for classification as Northern water milfoil or as Eurasian water milfoil. ERC reported that the sample appeared to be Eurasian water milfoil.

The palustrine open water, palustrine emergent, palustrine scrub shrub, and palustrine forested wetlands were all observed in August as they were in June. Aquatic plant densities were greatly increased in Glenmere Lake in August as compared to June.

Several grab samples of water milfoil were collected from the central areas of Glenmere Lake during the August 18, 2011 reconnaissance. Milfoil coverage and densities were significantly increased in August as compared to June. As before, samples of milfoil were provided to CAES and ERC for identification. However, on this occasion, CAES reported that the sample appeared to be Eurasian water milfoil, consistent with ERC's similar conclusion from June 2011. Identification of Eurasian water milfoil is often complicated by the timing of the sampling event. In the case of Glenmere Lake, the additional growth occurring between June and August appears to facilitate a more straightforward identification of the species. However, Northern water milfoil may coexist with the Eurasian water milfoil in Glenmere Lake.

2.8 Threatened and Endangered Species

One of the critical resources within Glenmere Lake is the Northern cricket frog, which is listed as endangered within the state of New York. The Northern cricket frog is a small species of tree frog that prefers the margins of slow moving waterbodies including lakes, ponds, and rivers and then hibernates in adjacent upland areas. This frog is inclined to areas with open muddy to sandy banks having sparse to dense aquatic vegetation or woody areas. They are often found living in the same habitat as American bullfrogs, American toads, green frogs and spring peepers.

The Northern cricket frog is found from eastern Texas up through southern New York State. Neither the World Conservation Union (now the International Union for Conservation of Nature) nor the USFWS lists the Northern cricket frog as being a threatened or endangered species within the United States. However, the NYSDEC has listed the frog as endangered within the state of New York. Studies documenting Northern cricket frog communities in and around Glenmere Lake indicate that it is the largest known Northern cricket frog population within New York State.

The presence of Northern cricket frog communities in and around Glenmere Lake has been documented in a number of studies. Northern cricket frog surveys conducted by the NYSDEC began in the 1990s. These studies were described in Section 2.7 in the context of aquatic vegetation and are summarized below:

Field Studies by NYSDEC –The earliest available NYSDEC field sheet is dated July 13, 1993. During this study, only two frogs were observed although "100+" were heard calling. A follow-up study was completed by Rick Stevens on June 30, 1994. The report documents that 11 calls were heard and notes that Decoden verticillatus was abundant in the areas where the frogs were heard. The report includes a location map of identified frog calls. The mapped locations fall predominantly along the eastern edge of Glenmere Lake, from the northeast corner of the lake down to the northern portion of the southeast arm of the lake.

Continued monitoring by the NYSDEC Natural Heritage Program is indicated in two additional field sheets dated June 26, 2004 and July 16, 2004. Both field surveys were completed via canoe/kayak. The reports again identified populations based on vocalization with visual observations of the species occurring during the July 16 survey, wherein five calling males were identified. The June 26 report estimated 50 to 65 calling males in three subareas at the north end of the lake. The July 16 report estimated 93 to 110 calling males in 10 subareas. Both reports note that the presence of calling males and their numbers have remained stable over several years and that no evidence of disease/predation is apparent. Recommendations included annual population monitoring around the middle of the calling season to detect any large fluctuations in the population and increased patrolling to detect potential problems with all terrain vehicle (ATV) usage around the lake.

Field Studies by Allied Biological – Allied Biological conducted a Northern cricket frog survey in 2007 that focused on the determination of frog populations and their locations/intensity. The report was initiated in response to a proposed application of "Sonar" (fluridone) within the lake for vegetation control. This study was described in the previous section in the context of aquatic vegetation. Three shoreline transects were conducted with four points along each transect. At each point, water quality data was collected followed by listening for frog calls. Water quality sampling conducted by Allied Biological included water clarity, pH, temperature, and DO. The report indicates that the strongest frog calls occur at 9 p.m. and 1 a.m.

Mapping provided in the Allied Biological report indicates a full chorus along the southwest shore, with overlapping calls at the southeast edge where the main basin joins the southern basin. There were no calls identified for the northern half of the main basin. The report and its map indicate that the locations of highest intensity calls correspond to mapped wetland areas at the edges of the basins.

Field Studies by Herpetological Associates – Herpetological Associates, Inc. performed a Northern cricket frog survey at a parcel of land located on the northern shoreline of Glenmere Lake in April 2008. This study was conducted in connection with ongoing remedial assessment and cleanup efforts at the former Glenmere Estates buildings. The premise was that the land was potentially being used as a hibernation area and/or a migration route back to Glenmere Lake. The survey included frog hide boxes, frog traps, perimeter fences, and recording data. Hibernation spots were checked along the rock

edges of the overflow stream to the northwest of the lake and at the spring seep behind the buildings on site, the spring in the west meadow, and the rocky cliff face across the lake to the east. The study determined that cricket frogs were not using the old buildings, foundations, and spring seep as hibernaculum. It was inconclusive as to whether the overflow from Glenmere Lake was being utilized as Northern cricket frog habitat. The frogs were observed, however, in the easternmost portion of the site in early April 2008.

Herpetological Associates, Inc. noted that cricket frogs are one of the last frogs to emerge from hibernation in the northeast, and breeding does not peak until late May or June. Males call to attract mates until late August, vocalizing from grassy shrub thickets or lily pads during the day as well as night. Herpetological Associates, Inc. noted that it was not certain whether Northern cricket frogs were freeze tolerant during overwintering and hibernation.

Field Studies by Jonathan Micancin – Jonathan Micancin (University of North Carolina Department of Biology) asserts that the cricket frog has been in decline in New York for many years and attributes this decline to the removal of aquatic vegetation by intentional application of herbicides and increased mortality during hibernation as a result of shifts in climatic conditions. He further notes that frog habitat is not limited to the edges of wetlands. Rather, the frogs have been known to move up to 450 meters[5] from wetlands. Micancin's observations of the Glenmere Lake habitat in October 2008 resulted in identification of the frogs in upland habitat in the ATV usage areas and in the immediate vicinity of the proposed Glenmere Preserve housing development.

Field Studies by an Unknown Individual – A recent review of the Northern cricket frogs was completed by an anonymous author who contacted the NYSDEC directly. The anonymous report entitled "Confidential Observations of Glenmere Lake and Nearby Uplands" is dated August 3, 2009 and summarizes a reconnaissance of Glenmere Lake conducted on July 18, 2009. The observations include audio identification of cricket frog calls and dead vegetation. DO values were measured, with the lowest values occurring in the areas of dead submergent vegetation and high turbidity. The author expressed concern over an alleged "dead zone" identified as an area at the north end of the reservoir that has been treated with herbicides, stating that this area has been impacted by chemical applications.

Field Studies by J. G. Barbour – J. G. Barbour's report "Ecological Issues of Glenmere Lake" contained substantial vegetation information and was described in Section 2.7. His report included a reconnaissance of the site conducted on June 18, 2010, wherein cricket frog choruses were identified in the southern and eastern portions of Glenmere Lake. He drew a parallel between Glenmere Lake and Harriman State Park, noting that habitat is similar between the two lakes although lack of conservation at Harriman has resulted in a decline if not eradication of the cricket frog species in that area. He noted that herbicides or other chemicals may reduce or eliminate invertebrate food sources for the frogs such as

[5] Subsequent reports by Micancin indicate that the frogs move at least 600 meters from breeding areas.

the water lily planthopper[6] and that the Glenmere Preserve planned development should be reviewed more thoroughly for its potential impacts on the frog habitat.

Based on the NYSDEC field surveys of Glenmere Lake and the other reports discussed above, it is apparent that the reservoir supports Northern cricket frog populations. It is important that land use management within the contributing watershed to the lake and water quality management in the lake be reviewed and assessed to maximize water quality and habitat protection for preserving the Northern cricket frog populations. This is consistent with desired water quality protection relative to drinking water supply as well.

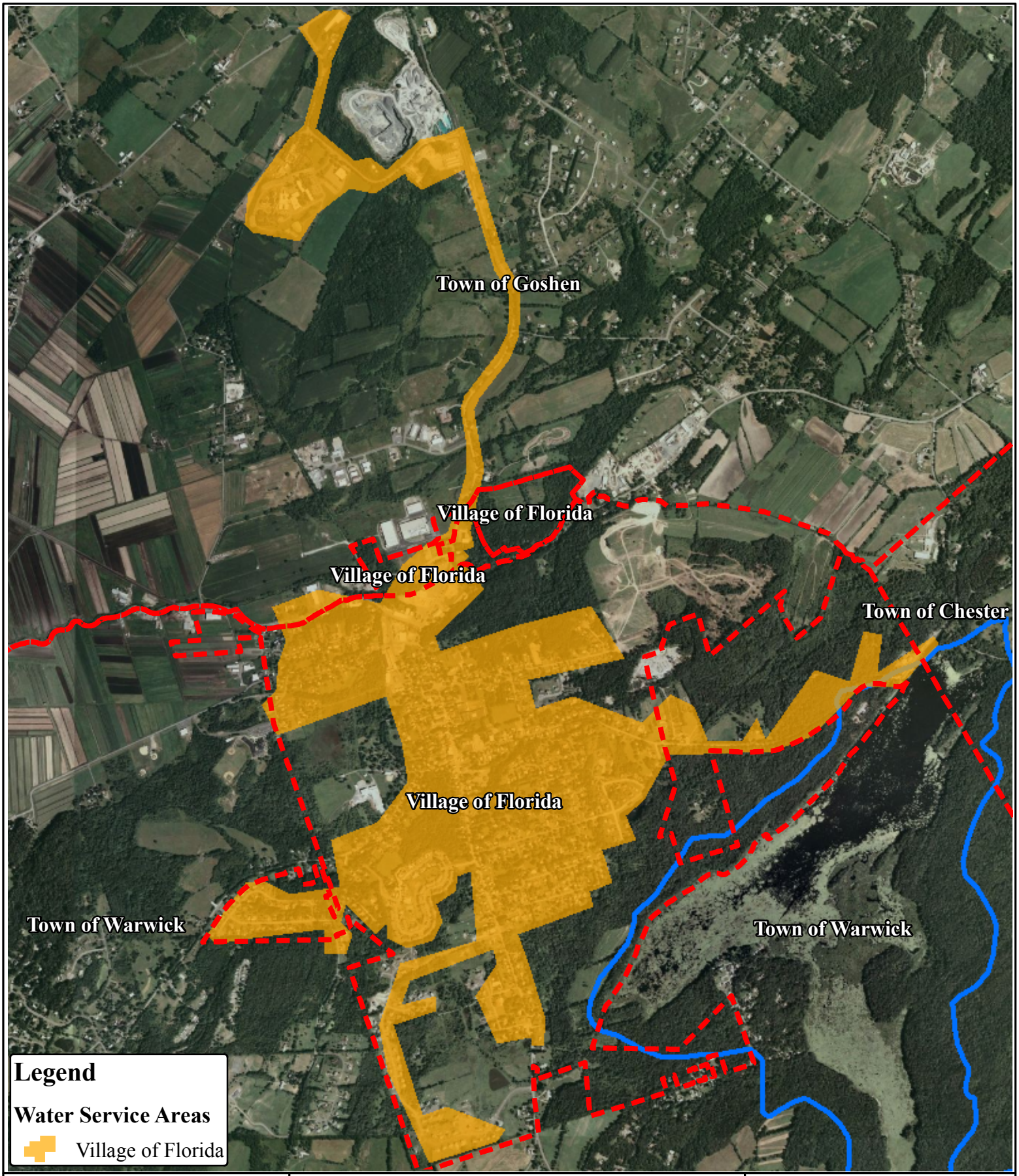
2.9 Water Supply

Glenmere Lake provides approximately 300,000 gpd of drinking water supply in the winter months and has reportedly delivered peak supplies in excess of 700,000 gpd in the summer. The average daily demand in the year 2010 was 473,044 gpd. Customers include 2,820 residents in the village of Florida who are served via 1,008 service connections and several customers outside the village including the Orange County Correctional Facility, Valley View Nursing Home, Hearthstone Apartments, the Department of Social Services facility, and Emergency Services facility. Figure 2-8 depicts the water distribution system.

The Village of Florida Comprehensive Plan is described in Section 3.4. Section IV of the plan provides background information about the water system. It states, "the bulk of Glenmere Lake is owned by Orange County and the rights to the top 15 inches of water were established by a water company in 1899. When the Village purchased the private water company in 1987, it acquired the rights to the water, water system, and filtration plant." The water treatment plant contains three filters of 500,000 gpd capacity each; with the built-in redundancy, capacity is 1.0 million gallons per day (mgd).

Several analyses of safe yield have been performed since the 1960s. A 1967 report entitled "Comprehensive Water Supply Study of Orange County, New York" prepared by Metcalf and Eddy described the dependable yield of Glenmere Lake to be 0.6 mgd and noted that previous yield estimates under less severe drought conditions (than those experienced in the mid 1960s) were as high as 2.0 mgd.

[6] Louis N. Sorkin, Senior Scientific Assistant, Department of Entomology at the American Museum of Natural History provided the following comment to Barbour: "I helped the New York Natural History Council identify a true bug species, Megamelus davisi, or the Water Lily Planthopper. This arthropod appears to be an important source of food for the Northern Cricket Frog (*Acris crepitans*) in the Glenmere reservoir."



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Water Distribution System

LOCATION: Orange County, NY

MMI#: 4515-01
MXD: P:\H2O_dist_system.mxd
SOURCE: Orange County GIS Division, Microsoft Virtual Earth

N

Glenmere Lake Watershed Assessment & Management Action Plan

Map By: SMG
Date: April 2011
Scale: 1" = 2,000'

SHEET: Figure 2-8

A safe yield analysis was prepared in April 1993 supported by a bathymetric survey and map. According to the 1993 safe yield analysis, the lake has a safe yield of 500,000 gpd and a total storage volume of almost 500 million gallons at elevation 533 feet (close to the spillway crest of 533.5 feet at the time).

A rule curve was established to allow for potential withdrawals greater than 0.5 mgd. During subsequent water supply permitting, a memorandum prepared by the Orange County Water Authority dated February 2000 further clarified the safe yield of Glenmere Lake to be 0.525 mgd when the reservoir elevation is above the rule curve and 0.460 mgd when the reservoir elevation is below the curve. The maximum allowable drawdown was to elevation 529.7 feet in order to preserve water for aquatic life.

Over the years, there have been allegations that sedimentation and the proliferation of aquatic vegetation have reduced the water depths in Glenmere Lake. Sedimentation typically occurs when runoff carries sediment into a water body. In the case of Glenmere Lake, there are some who believe that atmospheric deposition of "black dirt" from nearby agricultural fields has been prevalent for a number of years beginning in 1976 when many farmers in the black dirt region reportedly discontinued the planting of winter ground cover. Due to a lack of cover, high winds have carried soil from the bare black dirt fields and caused localized dust storms. This airborne soil – potentially laden with nutrient-rich agricultural fertilizers – has allegedly blown into Glenmere Lake, increasing the nutrient levels in the Lake and causing a few inches of sedimentation. This influx of nutrients could contribute to an acceleration of vegetative growth[7].

The field reconnaissance completed by MMI in 2011 included measurement of water depths at the 11 locations described in this section. These depths were compared to the bathymetric map that was completed as part of the safe yield study in 1993 by overlaying the 1993 map onto a GIS-produced map of the lake with Global Positioning System (GPS) coordinates of the 11 sample sites. In general, the bathymetry determined in 1993 appears to be the same as the bathymetry observed in 2011. Specifically, water depths in 2011 were within a foot of water depths depicted on the 1993 bathymetric map. This difference is within a reasonable margin of error given the enormous changes in locational technologies in the last 20 years. Hand-held GPS units were used on June 8 and August 18, 2011 whereas more traditional survey methods were likely used in 1993.

The similarity in water depths from 1993 to 2011 indicates that sedimentation of Glenmere Lake has not been significant. This is consistent with the small watershed and the lack of drainage into the lake, excluding the inlet stream at the south end. Any sedimentation attributed to atmospherically-deposited black dirt would be within the margin of error of the bathymetric mapping verification.

[7] The deposition of black dirt is believed by some to have helped increase the rate of aquatic vegetation proliferation in the lake, although this cannot be verified through the scope of this plan.

It is important to note that the lack of change in lake bathymetry is a somewhat separate matter than the gradual infill from aquatic vegetation. In places where vegetation has displaced water volume, such as the southeastern arm of the lake, the depths to the actual bottom of the lake are similar to the depths measured in 1993. Vegetation is growing on the lake bottom and as it dies and settles, the organic layer is becoming thicker. However, this has not apparently caused more than a foot of discrepancy between the 1993 mapping and the field measurements conducted in 2011.

The Village of Florida Comprehensive Plan includes anecdotal information about the capacity and yield of Glenmere Lake. According to the plan, the lake level has never dropped more than two feet. In the drought of 1964-1965, the lake was providing water to the village of Florida (population approximately 1,600), Orange Farm, and the village of Goshen. In 2001, it served Florida and pumped 1.0 mgd in order to serve Florida as well as parts of Goshen. Service to Goshen was reportedly suspended as water levels dropped below 20 inches.

The August 2010 Final Draft of the Orange County, New York Water Master Plan notes that the available supply in the village of Florida is 0.6 mgd inclusive of Glenmere Lake. The plan also notes that the nearby village of Goshen has a sizeable water supply deficit even with proposed improvements projected to come online in 2018. As water service is already provided to Goshen from Glenmere Lake, it is possible that requests from Goshen could increase in the near future (until Goshen's new sources come online) and continue at reduced levels beyond 2018.

2.10 Water Quality

Village of Florida Drinking Water Supply System

The Village of Florida owns and operates the water treatment plant located adjacent to the lake on the northwestern shore. The village operates a conventional water filtration plant. Raw (i.e., untreated) water samples are collected at the point of entry to the plant and analyzed for pH and turbidity. According to the chief operator of the water treatment plant, the NYS Department of Health does not require additional testing. A review of the Department of Health water quality monitoring tables confirms that the vast majority of monitoring is required at the entry point sample (i.e., the first location after the treatment plant) or within the distribution system, with the exception of turbidity. Turbidity must be measured in the raw water at least once every four hours, and it is also monitored in the treated water.

Annual drinking water quality reports published by the Village of Florida for the years 2010 and 2009 were obtained and reviewed. Based on the most recent report for 2010, treated water turbidity was highest in the month of August, coincident with the highest raw water turbidity in the same month. Nevertheless, treated water turbidity levels were below the maximum contaminant level (MCL) of one Nephelometric Turbidity Unit (NTU).

The Village of Florida monitors disinfection byproducts as required by Stage 1 of EPA's Disinfection Byproducts Rule. Disinfection byproducts broadly include trihalomethanes (often denoted as total trihalomethanes, or TTHM) and haloacetic acids (HAA5s). These compounds are formed in systems that use chlorine for disinfection when water age and other factors such as pH allow chemical reactions between chlorine and organic materials in the water. High levels of disinfection byproducts can indicate that raw water contains high levels of total organic carbon (TOC) and that water age is excessive in parts of the system.

In 2010, TTHM levels ranged from 36.6 micrograms per liter (ug/L) to 112.4 ug/L, and HAA5 levels ranged from 22.1 ug/L to 81.6 ug/L depending on the month and sample location in the system. Similar ranges were detected in the year 2009. The MCLs for TTHM and HAA5 are 80 ug/L and 60 ug/L, respectively. It is important to note that violations did not occur because Stage 1 of the Disinfection Byproducts Rule requires that averages be compared to the MCLs. Nevertheless, the occasional elevated levels of TTHM and HAA5 may indicate that TOC is relatively high in Glenmere Lake.

United States Geological Survey

In the 1990s and continuing into the last decade, the USGS completed a number of water quality assessments under the National Water Quality Assessment program. The nearest study conducted by the USGS was performed downstream of Glenmere Lake in the Wallkill River basin. Open-File Report 97-241 is entitled "Geohydrology and Water Quality of the Wallkill River Valley Near Middletown, New York." The study focused on the reach of the river and the underlying aquifer between Goshen and Middletown. Based on the size of the watershed at this location, none of the findings are particularly relevant to water quality in Glenmere Lake.

State of New York

In order to fulfill requirements of the Federal Clean Water Act, the NYSDEC must provide periodic assessments of the quality of the water resources in the state and their ability to support specific uses. These assessments reflect monitoring and water quality information drawn from a number of programs and sources both within and outside the DEC. This information has been compiled by the NYSDEC Division of Water and merged into an inventory database of all waterbodies in New York State. The database is used to record current water quality information, characterize known and/or suspected water quality problems and issues, and track progress toward their resolution. This inventory of water quality information is the division's Waterbody Inventory/Priority Waterbodies List (WI/PWL).

The Lower Hudson River Basin WI/PWL was last published in 2008. Glenmere Lake is listed as "unassessed" in this publication. Browns Creek is not listed or mentioned in the report. Quaker Creek is listed as impaired for aquatic life along its 41.5-mile length.

Suspected problems include low levels of oxygen, flow alteration, nutrients, and sediment. Suspected sources of these problems include agriculture, hydrologic modification, and wastewater treatment. An additional possible source is stream bank erosion. Irrigation withdrawals were mentioned as possible contributors to the "sluggish" flows in the creek.

While Quaker Creek appears to have a number of water quality issues, no direct correlation to Glenmere Lake or its watershed was established. However, the goals of the subject management plan are consistent with the goal of improving water quality in the Quaker Creek subwatershed.

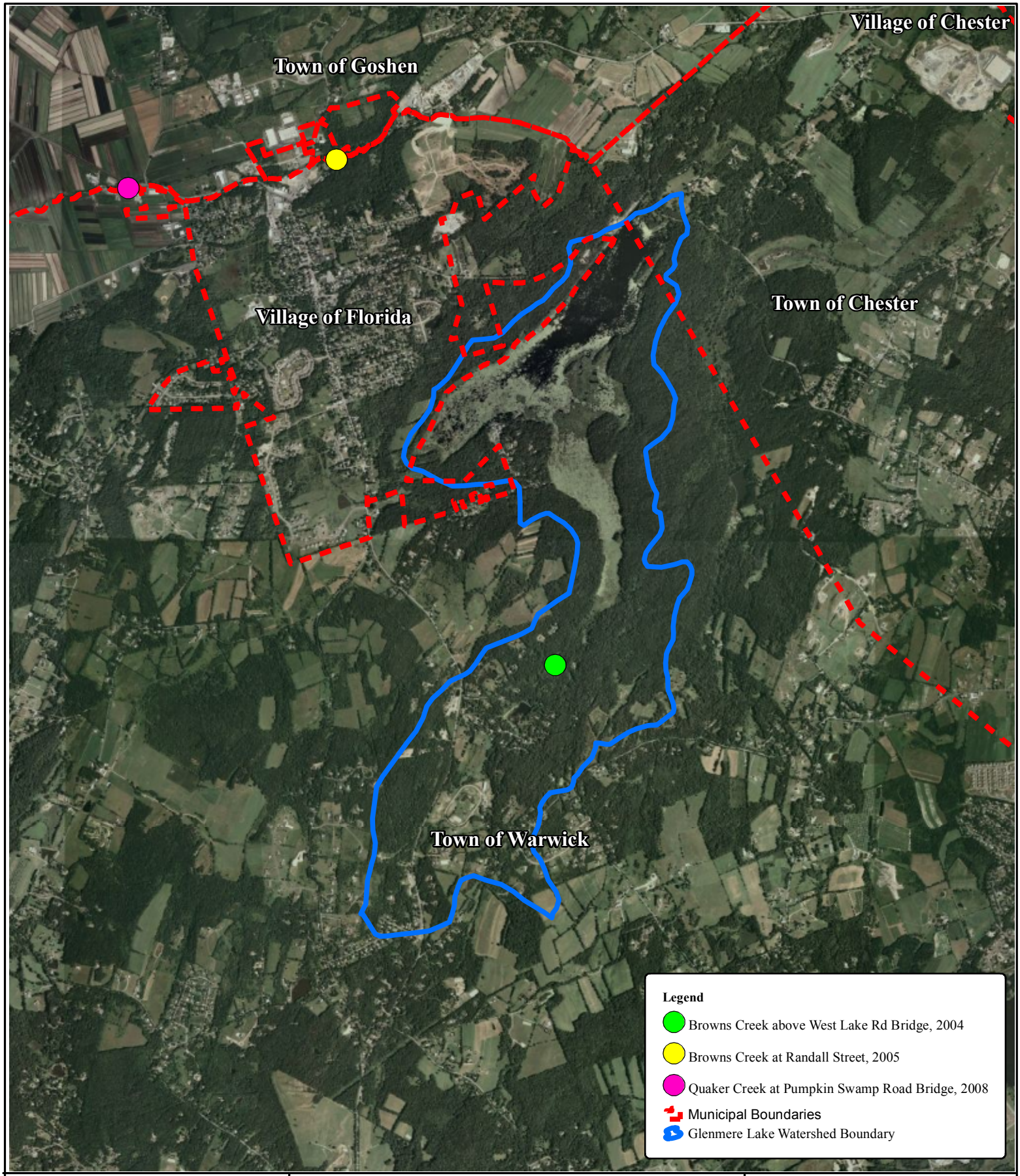
Orange County

The Orange County Soil and Water Conservation District developed and published the Wallkill River Watershed Conservation and Management Plan in 2005. The watershed plan includes a discussion of existing water quality data, but none of the data was collected from locations in the Glenmere Lake watershed or from the lake itself. Most of the data was collected from the Wallkill River and its major tributaries and, therefore, is representative of numerous factors in the large watershed.

The Orange County Water Authority has been conducting a biomonitoring project for several years. The Water Quality Biomonitoring Project Summary Report for Years 2004 to 2006 was published in the year 2008. This report includes two sample sites along Browns Creek (5489-002 and 5489-008) and one along Quaker Creek (5489-003). Sample sites are depicted in Figure 2-9.

The NYSDEC methodology employed by the biomonitoring project uses four different analyses for assessing water quality, which are known as metrics. These four metrics are then combined to produce one overall water quality score called the Biological Assessment Profile (BAP). The BAP is expressed as a numerical value from 0 to10 (where 10 equals the best possible water quality) and a narrative description. The narrative descriptors are "non-impacted, slightly impacted, moderately impacted, and severely impacted," each of which corresponds to a range of numerical BAP values. A BAP score of 0 to 2.50 is termed severely impacted; 2.51 to 5.00 is moderately impacted; 5.01 to 7.50 is slightly impacted; and 7.51 to 10.00 is non-impacted.

The NYSDEC methodology also includes a separate metric known as Impact Source Determination (ISD), which is a ranking of the most likely causes of water quality impacts at each site. The impact source categories are currently defined as non-point source nutrient enrichment, organic (sewage and animal waste), complex (municipal and industrial inputs), toxics, siltation, impoundments, and natural inputs.



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Biomonitoring Sites

LOCATION: Orange County, NY

MMI#: 4515-01
MXD: P:\H2Oshed_Boundary.mxd
SOURCE: Orange County GIS Division, Microsoft Virtual Earth

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Glenmere Lake Watershed Assessment & Management Action Plan

Map By: JBH
Date: April 2011
Scale: 1" = 3,000'

SHEET: Figure 2-9

Sample results for Browns Creek and Quaker Creek are presented below.

- In September 2004, the BAP score was 7.8 for Browns Creek at West Lake Road. This site is located in the town of Warwick within the Glenmere Lake watershed. The score of 7.8 represented a nonimpacted stream with very good water quality and a diverse macroinvertebrate community. Thus, at the time of the rating, water quality appeared to be good in Browns Creek, which is consistent with the protection of portions of the Glenmere Lake watershed and the use of the lake for public water supply. The ISD scores for this site were 37 (natural), 50 (non-point sources), 29 (toxics), 18 (organic inputs), 60 (municipal/industrial), 27 (siltation), and 52 (impoundment). The ISD scores indicate a benthic community structure most similar to one affected by municipal/industrial inputs, but the finding was reportedly spurious as the subsample included species that are indicators of good water quality.

- The BAP score was 6.0 for a different point in Browns Creek in 2005. This site is located near the village of Florida at Randall Street. The score of 6.0 represented a slightly impacted stream with an altered macroinvertebrate community. Thus, water quality appeared to be good in Browns Creek, which is consistent with the protection of portions of the Glenmere Lake watershed and the use of the lake for public water supply. The ISD scores were not available for this site.

- The BAP score was 2.53 for Quaker Creek in the year 2005. This site is located in the town of Warwick downstream of the Glenmere Lake watershed. The score of 2.53 for Quaker Creek represented a severely impacted stream with poor water quality and a limited macroinvertebrate community. This score is consistent with the discussion related to Quaker Creek in the Lower Hudson River Basin WI/PWL. As mentioned above, while Quaker Creek appears to have a number of water quality issues, the goals of the subject management plan are consistent with the goal of improving water quality in the Quaker Creek subwatershed. The ISD scores were not available for this site.

- Quaker Creek was sampled again (location 5489-015, near Pumpkin Swamp Bridge Road) in September 2008. The BAP at this time was 6.06, which was much improved over the other sample in Quaker Creek. The score represented a slightly impacted stream with good water quality and an altered macroinvertebrate community. The individual ISD scores for this site were 33 (natural), 52 (non-point sources), 37 (organic inputs), 56 (impoundments), 34 (municipal/industrial sources), 38 (toxics), and 42 (siltation). These ISD scores suggest that non-point sources and impoundments have affected the water quality and benthic community.

Biomonitoring efforts in 2009 and 2010 did not target any locations along Browns Creek or Quaker Creek.

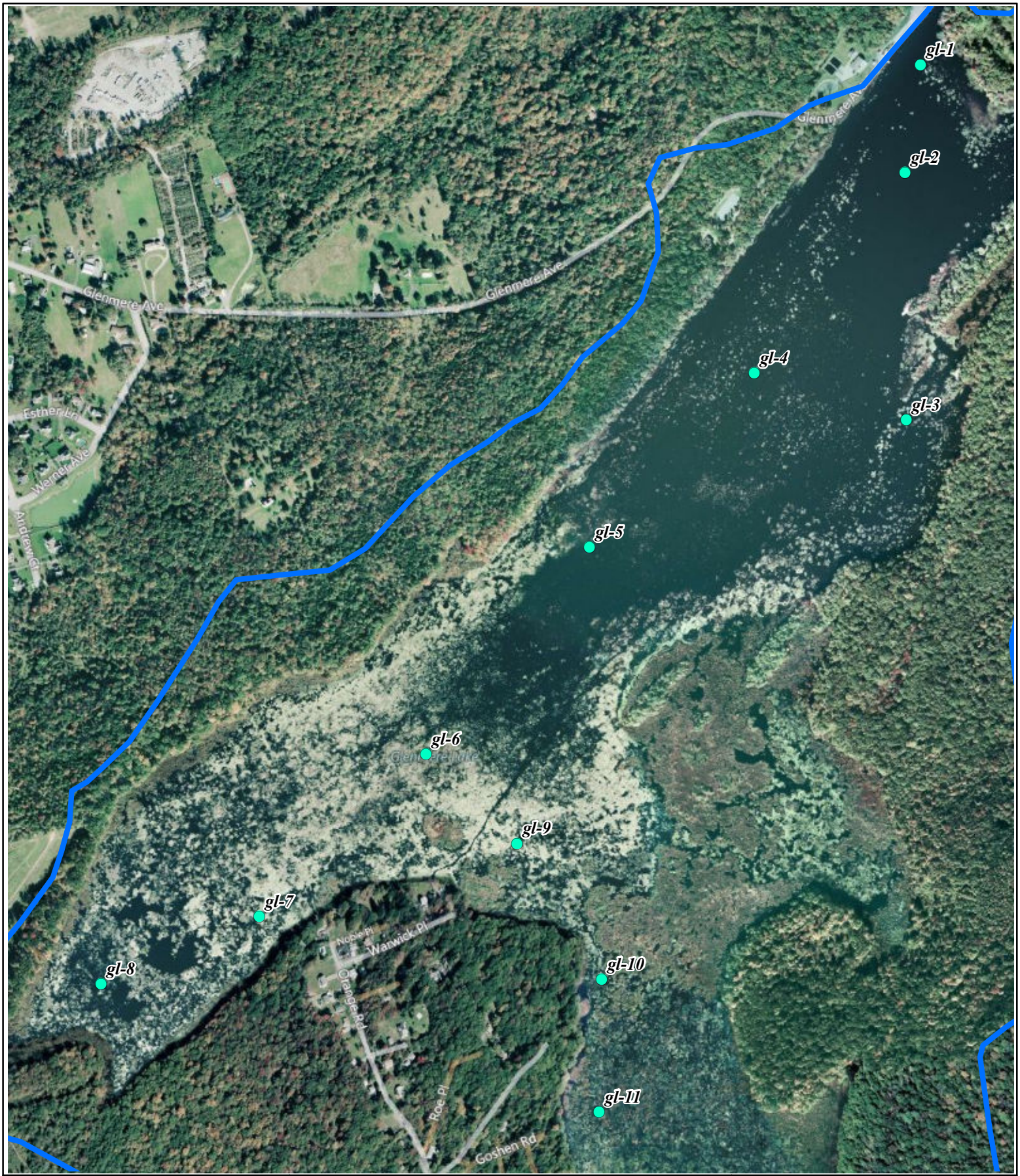
June 2011 Field Investigations by MMI

A water-based reconnaissance of Glenmere Lake was completed by MMI on June 8, 2011. During this reconnaissance, observations from the shoreline and from a canoe were made by Mr. Matthew Sanford, PWS, and Mr. David Murphy, Professional Engineer (P.E.) and a senior hydrologist with the firm. Additionally, Mr. Murphy and Mr. Sanford measured water depths, transparency, temperature, and DO at 11 locations in the lake depicted on Figure 2-10. Finally, Mr. Sanford completed a general assessment of the wetland communities present within Glenmere Lake. This assessment did not include in–depth vegetation surveys of the entire lake. General vegetative communities and plant species observation were made from the canoe and the shoreline.

MMI measured DO levels in Glenmere Lake on June 8, 2011 at 11 sites. Sites GL-1 through GL-4 are located in the northern, predominantly unvegetated portion of the lake. Sites GL-5 through GL-9 were taken in the slightly to mostly vegetated, moderate depth center area to the southwestern arm of the lake while sites GL-10 and GL-11 were taken in the heavily vegetated and shallow southeastern arm of the lake.

TABLE 2-4
Dissolved Oxygen Levels (mg/L) in Glenmere Lake, June 8, 2011

Depth (feet)	GL-1	GL-2	GL-3	GL-4	GL-5	GL-6	GL-7	GL-8	GL-9	GL-10	GL-11
0	7.25	7.71	7.61	7.49	6.89	6.93	6.71	6.98	6.87	3.41	2.64
2	7.59	7.83	7.54	7.12	6.96	7.23	5.92	6.73	6.54	1.71	1.03
4	6.89	7.46	7.40	6.60	4.74	2.61	3.18	4.77	3.79	0.60	
6	6.29	5.90	6.65	4.50	1.25	0.11	0.22	0.17			
8	1.69	3.77	3.49	1.65							
10		0.85									



SOURCE:
Basemap:
Bing Maps Hybrid datalayer (c) 2010 Microsoft Corporation and its data suppliers

Drainage Basin Boundary:
Orange County Office of Information Services (5/25/2007)

Figure 2-10: Locations of Temperature and Dissolved Oxygen Profiles

LOCATION:
Orange County, NY

N

Glenmere Lake Watershed Assessment & Management Plan

Map By: SMG
MMI#: 4515-01
MXD: P:\Fig_2-10.mxd
Date: October 25, 2011
Scale: 1 inch = 700 feet

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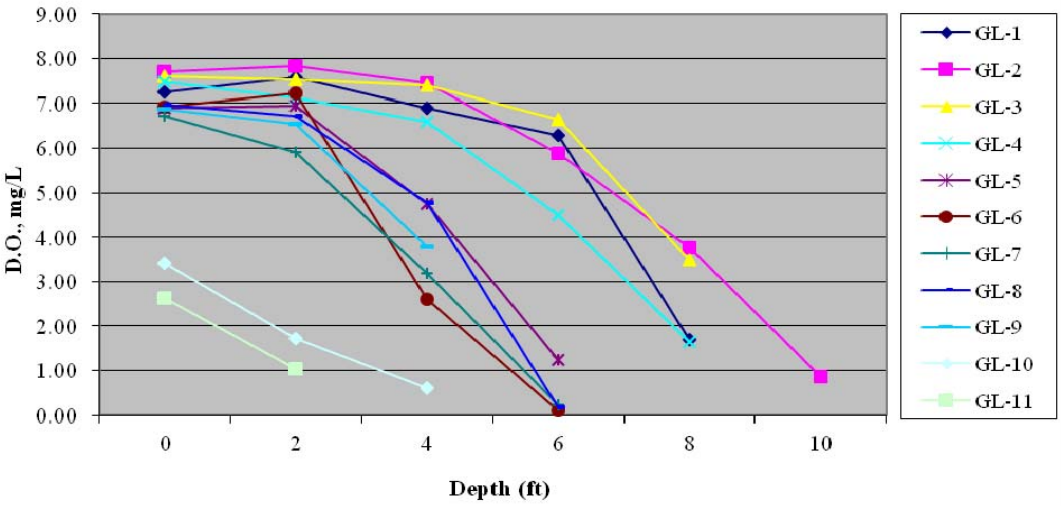
Figure 2-11
Glenmere Lake Dissolved Oxygen Levels, June 8, 2011



Notes

- GL-1 to GL-4 are in the northern part of the lake. These sites have similar trends in DO, with areas below six feet unacceptable for biota relative to DO.
- GL-5 to GL-9 are in the slightly vegetated middle (GL-5) and predominantly vegetated southwestern part of the lake. These sites have similar trends in DO, with areas below four feet unacceptable for biota relative to DO.
- GL-10 and GL-11 are in the heavily vegetated and shallow southeastern part of the lake. This area is unacceptable for fish habitat relative to DO likely as a result of high biochemical oxygen demand from organic matter decay.

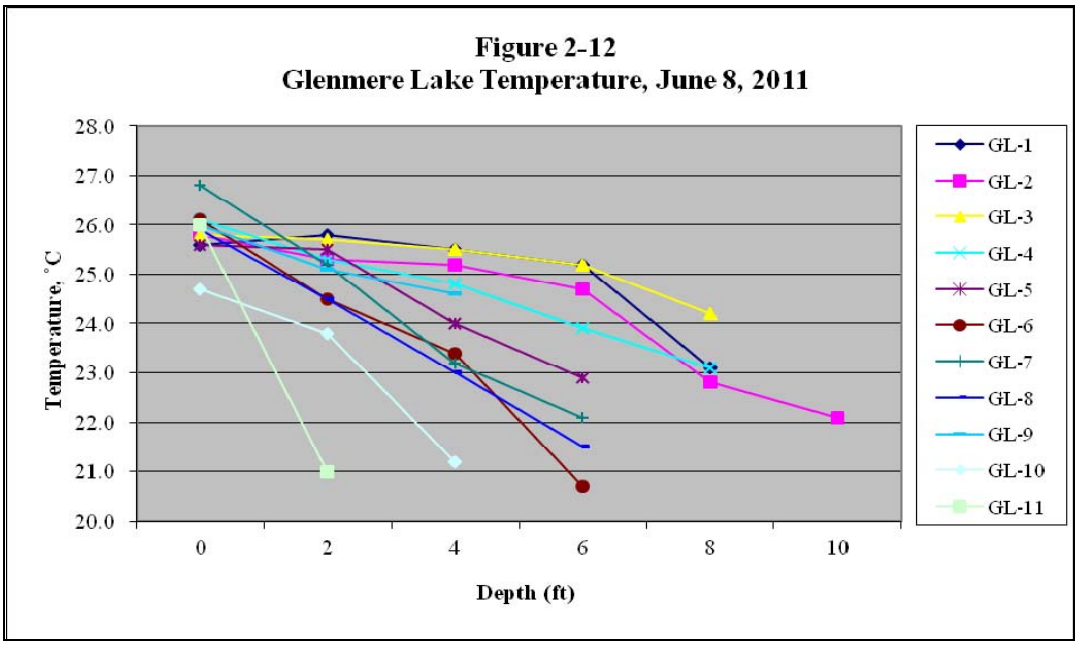
DO levels that are suitable to aquatic biota (levels greater than 5.0 mg/L) were found in the top six feet of water in the northern part of the lake and the top two to four feet of water in the central, southern, and southwestern parts of the lake.

In addition to the DO sampling, MMI conducted temperature monitoring at each location and depth on June 8, 2011. The atmospheric pressure as measured in Montgomery, New York during the sampling averaged 759 mm mercury (Hg), essentially the standard pressure value. Results are presented in Table 2-5 and Figure 2-12.

TABLE 2-5
Temperatures (°C) in Glenmere Lake, June 8, 2011

Depth (feet)	GL-1	GL-2	GL-3	GL-4	GL-5	GL-6	GL-7	GL-8	GL-9	GL-10	GL-11
0	25.6	25.8	25.8	26.1	25.6	26.1	26.8	25.9	26.0	24.7	26.0
2	25.8	25.3	25.7	25.3	25.5	24.5	25.2	24.5	25.1	23.8	21.0
4	25.5	25.2	25.5	24.8	24.0	23.4	23.2	23.0	24.6	21.2	
6	25.2	24.7	25.2	23.9	22.9	20.7	22.1	21.5			
8	23.1	22.8	24.2	23.1							
10		22.1									

Figure 2-12
Glenmere Lake Temperature, June 8, 2011



Notes

- GL-1 to GL-4 are in the northern part of lake. GL-9 is in the predominantly vegetated southern part of the lake. These sites have similar trends in temperature, with a metalimnion beginning at approximately six feet in depth.
- GL-5 to GL-8 are in the slightly vegetated middle (GL-5) and predominantly vegetated southwestern part of the lake. These sites have a similar temperature trend, namely a near steady decrease with depth.
- GL-10 and GL-11 are in the heavily vegetated and shallow southeastern part of the lake and show steep declines in temperature in its shallow depths.

The range of temperatures equates to approximately 70 to 80 degrees F. The inflections in the lines for GL-1 and GL-2 on Figure 2-12 show that only the deeper zone in the northern portion of Glenmere Lake is sufficiently deep to be thermally stratified. Even in the northern part of the lake, the stratification is not strong as the temperature range is not wide. Other parts of the lake have temperatures that generally decrease linearly with depth such as GL-7 and GL-8, indicating a lack of stratification.

The shallowest sites (GL-10 and GL-11) demonstrated the steepest gradients in temperatures over their shallow profiles. Along with the bottom sample at GL-6, some of the coolest waters in the lake were measured in the southern part of the lake above the bottom sediments. While cooler temperatures are sometimes indicative of ground water discharge to a lake, these temperatures (as low as 69 degrees F at the bottom of site GL-6) are still too elevated to demonstrate significant ground water discharge. Note that ground water is on the order of 55 degrees F and would cause temperatures at the bottom to be on the order of 60 degrees F if discharge was very strong.

A more likely scenario for the steep temperature gradients in the southern part of the lake is that mixing is poor, which allows the upper surface to warm faster than the deeper waters. It was relatively breezy in the northern part of the lake during the field

reconnaissance, and mixing was likely occurring there whereas the air was still in the southern portion of the lake.

The measured temperatures and DO levels in Glenmere Lake can be compared to saturated levels to determine the overall amount of DO saturation in the lake. Based on the results in Tables 2-4 and 2-5, the upper layer of the lake has approximately 80% or greater oxygen saturation. This is an indicator of appropriate DO levels for aquatic biota in the upper levels of the main part of the lake.

Table 2-6 summarizes secchi disc readings for the 11 sample locations. Note that transparency was lowest in the areas with the highest density of aquatic vegetation. The turbidities observed in the lake are likely due to suspended organic matter as opposed to high algae content.

TABLE 2-6
Transparency by Secchi Disc, June 8, 2011

Site	Transparency (feet)	Aquatic Vegetation
GL-1	6.0	Not dense
GL-2	6.0	Not dense
GL-3	6.0	Not dense
GL-4	5.5	Moderate density
GL-5	5.5	Moderate density
GL-6	5.5	Moderate density
GL-7	4.5	Moderate density
GL-8	3.5	Dense
GL-9	2.5	Dense
GL-10	3.5	Dense
GL-11	2.0	Dense

August 2011 Field Investigations by MMI

A second water-based reconnaissance of Glenmere Lake was completed by MMI on August 18, 2011. During this reconnaissance, observations from the shoreline and from a canoe were made by Mr. Matthew Sanford, PWS, and Mr. Shawn Goulet, Environmental Scientist. Additionally, Mr. Goulet and Mr. Sanford measured water depths, transparency, temperature, and DO at eight of the original 11 locations in the lake. Finally, Mr. Sanford updated the general assessment of the wetland communities present within Glenmere Lake. As before, this assessment did not include in–depth vegetation surveys of the entire lake.

MMI measured DO levels in Glenmere Lake on August 18, 2011 at eight of the 11 sites in Glenmere Lake. Sites GL-8, GL-10, and GL-11 were omitted as the aquatic vegetation was much denser. DO was measured at two-foot depth increments at each location (refer to Table 2-7 and Figure 2-13). Ten-foot samples were achieved at GL-1 and GL-3

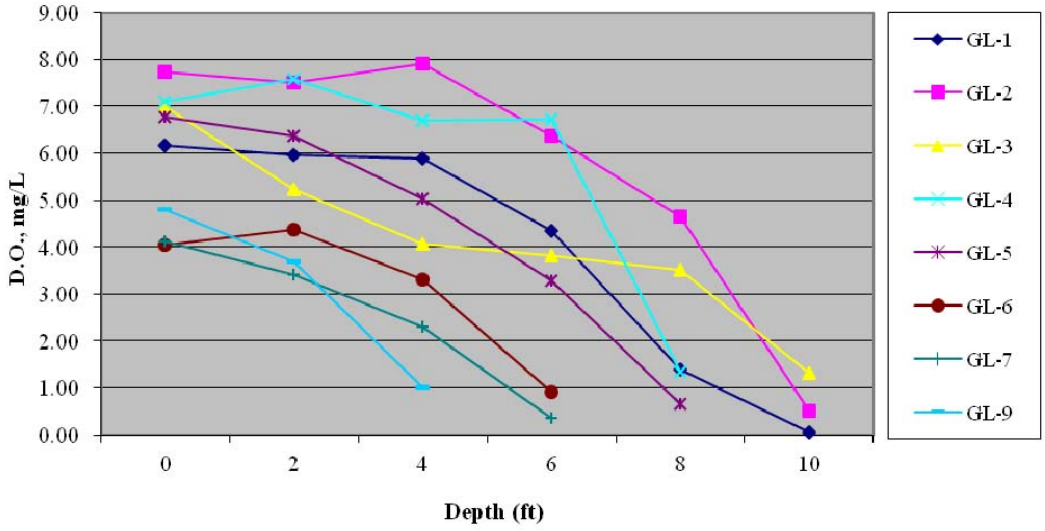
whereas they were not characterized on June 8, 2011. These 10-foot samples are generally characteristic of the bottom sediment.

Overall, DO levels were lower than they were in June 2011. With reference to Figure 2-13, the spread or variability of DO levels was greater in August than it was in June, with a larger percentage of lower levels in August, consistent with the season and the greater density of aquatic vegetation.

TABLE 2-7
Dissolved Oxygen Levels (mg/L) in Glenmere Lake, August 18, 2011

Depth (feet)	GL-1	GL-2	GL-3	GL-4	GL-5	GL-6	GL-7	GL-8	GL-9	GL-10	GL-11
0	6.16	7.74	6.99	7.11	6.78	4.05	4.11	--	4.79	--	--
2	5.96	7.50	5.22	7.59	6.38	4.36	3.40	--	3.68	--	--
4	5.90	7.90	4.06	6.70	5.02	3.32	2.29	--	1.00	--	
6	4.34	6.36	3.82	6.72	3.28	0.92	0.36	--			
8	1.38	4.64	3.52	1.34	0.67						
10	0.05	0.50	1.32								

Figure 2-13
Glenmere Lake Dissolved Oxygen Levels, August 18, 2011



Notes

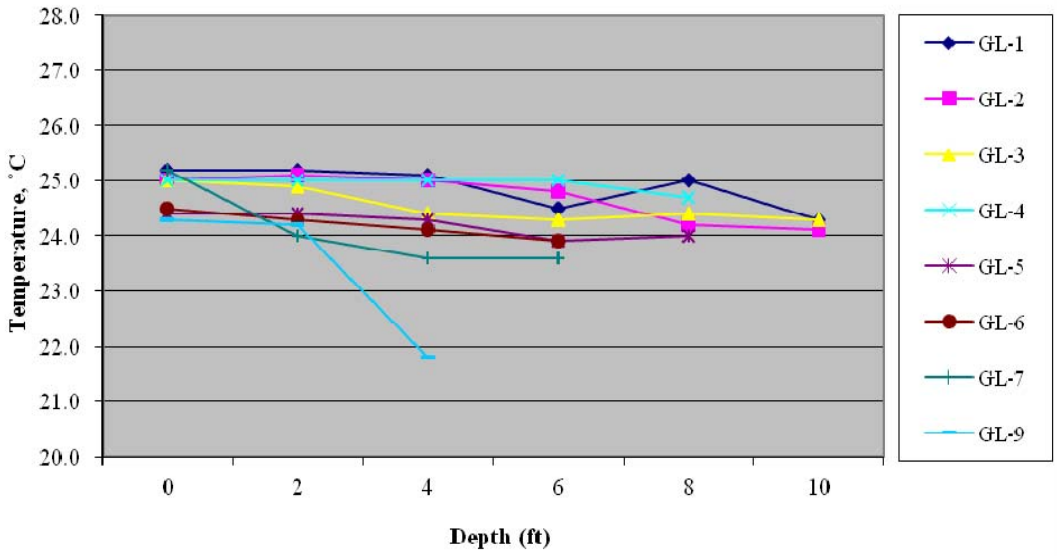
- GL-1 to GL-4 are in the northern part of lake. These sites have similar trends in DO, with areas below six feet unacceptable for biota relative to DO with the exception of GL-3 where areas below four feet are unacceptable.
- GL-5 to GL-9 are in the slightly vegetated middle and predominantly vegetated southwestern part of the lake. These sites have similar trends in DO, with areas below four feet unacceptable for biota relative to DO. Since the June sample event, the DO profile for GL-1 shifted toward that of GL-5.

In addition to the DO sampling, MMI conducted temperature monitoring at each location and depth on August 18, 2011. Results are presented in Table 2-8 and Figure 2-14.

TABLE 2-8
Temperature (°C) in Glenmere Lake, August 18, 2011

Depth (feet)	GL-1	GL-2	GL-3	GL-4	GL-5	GL-6	GL-7	GL-8	GL-9	GL-10	GL-11
0	25.2	25.0	25.0	25.0	24.4	24.5	25.2	--	24.3	--	--
2	25.2	25.1	24.9	25.0	24.4	24.3	24.0	--	24.2	--	--
4	25.1	25.0	24.4	25.0	24.3	24.1	23.6	--	21.8	--	
6	24.5	24.8	24.3	25.0	23.9	23.9	23.6	--			
8	25.0	24.2	24.4	24.7	24.0						
10	24.3	24.1	24.3								

Figure 2-14
Glenmere Lake Temperature, August 18, 2011



Temperatures in the lake in August were much more uniform than they were in June, without evidence of the weak thermal stratification. The maximum temperatures on August 18 were lower than those measured on June 8, which is counterintuitive given the season. There are at least two reasons why slightly cooler temperatures could have developed on the surface on August 18 in comparison to June 8. First, lower nighttime temperatures could have cooled the surface water. This typically occurs later in the fall and prompts fall "turnover" in lakes but can occur earlier in the season. When a sufficiently cool mass of water develops on the surface, it will sink to the bottom because

of its higher density and displace warmer bottom water upward. This mixes the water column. Complicating matters, radiational cooling on a very clear cool night can cause local cooling that is not picked up by the weather station. The large surface area of Glenmere Lake relative to total volume may amplify the effect of radiational cooling.

The second reason for cooler surface water could be an influx of cool water from precipitation and runoff. However, precipitation was not recorded at the nearby Goshen weather station (www.wunderground.com) during the week preceding the August 18, 2011 reconnaissance.

Thus, the apparent cooling of the surface of Glenmere Lake can likely be attributed to the weather and air temperatures that occurred prior to August 18, 2011. For example, the lowest temperature recorded at the Goshen weather station during the week prior to August 18 was 54.7 degrees, and the highest was 85.2 degrees. In comparison, the highest temperature recorded in the week prior to June 8 was 88.6 degrees. However, air temperatures are only part of the picture. Sunshine on the lake surface and the radiational cooling described above can also affect temperature.

Table 2-9 summarizes the secchi disc readings for the sample locations and compares them to the readings from June 8, 2011. Note that transparency was generally the same or slightly lower in August than it was in June, with the exception of site GL-9 where it appeared to increase slightly.

Table 2-9
Comparison of Transparency by Secchi Disc

Site	Transparency (feet) on 6/8/11	Transparency (feet) on 8/18/11
GL-1	6.0	5.0
GL-2	6.0	4.5
GL-3	6.0	5.0
GL-4	5.5	5.0
GL-5	5.5	6.0
GL-6	5.5	5.0
GL-7	4.5	4.0
GL-8	3.5	Not measured
GL-9	2.5	4.5
GL-10	3.5	Not measured
GL-11	2.0	Not measured

Summary

Despite the fact that its bottom waters are lacking in DO, Glenmere Lake has a variety of areas with DO levels that are appropriate for aquatic biota. This concurs with historical anecdotal and scientific evidence that suggests that Glenmere Lake is a healthy amphibian and fisheries habitat. In addition to the Northern cricket frog, the lake

reportedly supports a variety of other amphibians and mammals as well as fish such as pickerel and small-mouth bass.

Temperature of the water and atmospheric pressure have the largest effect on the solubility of oxygen in water. According to the USGS, at 20 degrees Celsius (°C) and standard atmospheric pressure (760 millimeters of mercury, or mmHg), the saturation level of DO in water is 9.1 mg/L. At 27 °C, this value decreases to 7.9 mg/L. Table 2-10 presents the solubility of oxygen at standard atmospheric temperature over a variety of temperatures.

The DO levels measured over a range of temperatures in Glenmere Lake can be compared to saturated levels to determine the overall amount of DO saturation in the lake. The upper layer of the lake has approximately 80% or greater oxygen saturation, another indicator of appropriate DO levels for aquatic biota.

TABLE 2-10
Solubility of Oxygen in Water at Standard Atmospheric Pressure (760 mmHg)

Temperature °C	Solubility of Oxygen in Water (mg/L)
20	9.1
21	8.9
22	8.7
23	8.6
24	8.4
25	8.2
26	8.1
27	7.9
28	7.8
29	7.7
30	7.5

2.11 Source Water Assessment

The NYS Department of Health completed the Source Water Assessment Report for Glenmere Lake in 2005. Appendix A contains a copy of the report. The report was completed in accordance with the requirements of the 1996 amendments to the Safe Drinking Water Act. A source water assessment can be used to target and implement enhanced source water protection measures such as inspections, land use regulations, land acquisitions, septic system maintenance, and education.

The source water assessment for Glenmere Lake found a "moderate susceptibility to contamination for this source of drinking water. The amount of pasture in the assessment area results in a medium potential for protozoa contamination. No permitted discharges

are found in the assessment area. There are no noteworthy contamination threats associated with other discrete contaminant sources. Additional sources of potential contamination include: septics."

A number of individual conclusions of the source water assessment include the following:

- As a potential source of contamination, transportation routes were found to have a "low" potential impact to the water source.
- The natural sensitivity rating and contaminant prevalence rating for organic contaminants such as petroleum was "low."
- The natural sensitivity rating for other chemicals such as pesticides, metals, phosphorus, nitrates, turbidity, and disinfection byproduct precursors was "medium" whereas the contaminant prevalence rating was "low."
- The natural sensitivity rating for microbial organisms was "medium," and the contaminant prevalence rating for protozoa was "medium" due to the pastures in the watershed.

Finally, the following observations were made by the state while conducting the source water assessment. Note that all items are copied verbatim without corrections for street or place names; and "inlet" is presumed to be the intake to the water treatment plant.

- Scavenger waste site in watershed approximately 13,000 feet away from inlet.
- Sewer lines may be under Glenmere Avenue approximately 75 feet from inlet.
- Inlet is approximately 75 feet from Glenmere Avenue.
- Glenmere Homesite development is adjacent to reservoir, approximately 100 homes with septic systems within 200 feet of reservoir and approximately 5,000 feet from intake.[8]
- A horse farm is also located within the watershed approximately 1,000 feet from the reservoir and approximately 9,000 feet from the intake.
- A small garden nursery is also located within the watershed approximately 4,000 feet from the reservoir and 11,500 feet from the intake.
- A small strip mall is located at the edge of the watershed approximately 8,000 feet from the reservoir and approximately 17,500 feet from the intake.

2.12 Glenmere Lake Property Remediation

An additional source of potential contamination in the vicinity of Glenmere Lake is the "Glenmere Lake Property." This property is an approximately 9.9-acre brownfield site located at the north end of Glenmere Lake. The site is owned by Orange County and includes the remnants of several buildings, including a former barn, a former milk barn,

[8] This statement was not verified as part of this watershed management plan. One of the recommendations of this plan is to conduct a sanitary survey. When conducted, the survey can determine how many homes have septic systems within certain distances of the lakeshore.

as well as a dilapidated former house and pumphouse. In addition to the building remnants, a variety of debris has been abandoned or dumped on the property.

A remedial investigation was conducted to identify contaminants of concern. Contaminants of concern on this site include lead and arsenic in the soil and sediment downgradient of the site (in Glenmere Lake) and unspecified petroleum in the sediments surrounding former storage tanks located on site. Contamination at the site is reportedly due to previous daily operation and activities and the deterioration of the buildings and debris.

A total of four underground storage tanks and one aboveground storage tank were formerly present at the site and removed as part of an interim remediation measure. The contents of the tanks and approximately 470 gallons of oil-contaminated water were disposed of off site. A 620-square-foot area was excavated to remove lead- and petroleum-contaminated soil totaling 204.5 tons.

The NYSDEC issued a Record of Decision regarding the Glenmere Lake property in March 2011. The selected remedy includes:

- A remedial design program to provide the details necessary for construction, maintenance, and monitoring of the remedial program.
- Demolition and off-site disposal of existing buildings (which represent a source of lead contamination) and off-site disposal of solid waste present at the site.
- Excavation and off-site disposal of contaminated soils that exceed soil cleanup objectives for lead and arsenic, with replacement by clean fill.
- Removal (excavation or dredging) and off-site disposal of contaminated sediments in Glenmere Lake within 40 feet of shore with revegetation. This work will include efforts to reduce potential impacts to Northern cricket frogs and their habitat during construction and to maximize the value of Northern cricket frog habitat during restoration.

Cleanup of this site is expected, among other goals, to reduce the potential for related contaminants to impact the village of Florida water supply.

3.0 PLANS, POLICIES, AND REGULATIONS

3.1 Existing Water Supply Policies and Regulations

State of New York

The NYS Public Health Law allows local water supply officials to initiate a process leading to enactment of watershed rules and regulations by the Commissioner of the State Health Department. These rules were first developed in the late 19th century to protect tributary streams and reservoirs used to supply drinking water. They were later applied to public wellfields and adjacent aquifer areas. Most of the nearly 200 public water supply systems in New York that adopted watershed rules did so prior to 1940.

Watershed rules specify minimum linear setbacks for different uses. For example, many regulations prohibit the location of salt storage sites within 500 feet of public supply wells, reservoirs, or tributary streams to reservoirs. The limitations of existing watershed rules were documented in the 1981 NYS Department of Health study "Water Supply Source Protection Rules and Regulations Project." The report concluded that water supply protection regulations should be customized to the particular conditions existing at the public supply wellfield or reservoir and that the concept of minimum acceptable distance does not address the differences between types of potential contaminants such as pathogens and synthetic organic chemicals.

The Village of Florida adopted its Rules and Regulations in 1925. Refer to Appendix B for a copy. The rules apply to "the entire drainage area of Glenmere Lake." The provisions of the rules and regulations are summarized in Table 3-1.

TABLE 3-1
Summary of Watershed Rules and Regulations for Village of Florida Water Supply

Narrative Section of Rules and Regulations	Section Numbers	Rules and Regulations
Privies Adjacent to Lake or Watercourse	1 through 6	Establishes various distances ranging from 75 feet to 500 feet from the lake and tributary watercourses for temporary and permanent privies of different types; discusses privy maintenance and disposal of wastes.
Sewage, House Slops, Sinks Wastes, Etc.	7 through 9	Establishes various distances and prohibitions for other types of wastes and wastewaters such as from sinks, laundry, baths, garages, garbage, refuse, and rinse waters.
Bathing, Animals, Manure, Compost, Etc.	10 through 13	Does not allow human bathing within 1,000 feet of the intake. Does not allow animal bathing/wading anywhere in lake. Does not allow stables or standing places for animals within 100 feet of the lake or tributary watercourse. Establishes distances and depths for disposal of manure and composting.

TABLE 3-1 (Continued)
Summary of Watershed Rules and Regulations for Village of Florida Water Supply

Narrative Section of Rules and Regulations	Section Numbers	Rules and Regulations
Dead Animals, Offal, Manufacturing Wastes, Etc.	14	Does not allow dead animals or waste in the lake or tributaries or within 300 feet of the lake or tributary watercourse if drainage is direct.
Fishing, Boating, and Ice Cutting	15	Does not allow boats or ice cutting within 300 feet of the intake and authorizes supervision of all ice cutting.
Camps	16	Does not allow camps, tents, or temporary housing within 500 feet of the lake or tributary watercourse.
Cemeteries	17	Does not allow cemeteries within 500 feet of the lake or tributary watercourse.
Inspections	18	Authorizes the water utility to make inspections and report results to the state.
Penalty	19	Authorizes a penalty of $100 per violation.

Watershed rules and regulations are unique in being the only controls specifically designed to protect public water supplies. These regulations are prepared jointly by the water purveyor and the NYS Department of Health local public health engineer. Enforcement responsibility, such as with the use of a designated "Watershed Inspector," rests with the water utility, the district health officer or, in some cases, the municipal or county health department. The NYS Department of Health provides a form entitled "Annual Report on Violations of Watershed Rules and Regulations" on its website. This form can be used by a water utility that has adopted rules and regulations. A copy is included in Appendix C.

The NYS Sanitary Code Subpart 5-1 covers public water systems. Section 5-1.12, "Water quality for existing sources of water supply" specifies the following (underlines added for emphasis herein):

(a) Whenever the supplier of water determines or is advised by the State that one or more of the MCLs set forth in this Subpart are or may be exceeded; or that effectiveness of treatment processes diminishes to the extent that a violation of the treatment techniques or MCLs set forth in this Subpart may occur; or that any deleterious changes in raw water quality have occurred; or that a change in the character of the watershed or aquifer has been observed which may affect water quality; or that any combination of the preceding exists, the supplier of water shall notify the State and do the following:

1. undertake a study to determine the cause or causes of such conditions, independent of known or anticipated treatment technology;
2. modify existing or install treatment to comply, to the extent practicable, with sections 5-1.30, 5-1.50, 5-1.51 and 5-1.60 of this Subpart;
3. initiate water sampling as needed to delineate the extent and nature of the cause of concern;

4. investigate all or part of the watershed or aquifer to verify any existing or potential changes in the character of the sources of water supply; and
5. submit a written report to the State within 30 days of the onset of the foregoing conditions summarizing the findings outlined in paragraphs (1) through (4) of this subdivision.

(b) The State may require the supplier of water to conduct sanitary surveys and to conduct water sampling related to watersheds and groundwater aquifers which are sources of water supply to identify and evaluate the significance of existing and potential sources of pollution and to report the results to the State. Also, sanitary surveys shall be used to evaluate the adequacy of the public water system, the source or sources of water supply and the water treatment plant to produce potable water.

The State of New York Title 10, Department of Health, Chapter II, Part 75, "Standards for individual water supply and individual sewage treatment systems" provides a linkage to watershed protection. Specifically, where sewage treatment systems are to be located on the watersheds of public water supplies, the rules and regulations enacted by the State Department of Health for the protection of these supplies must be observed.

Section 128-3.8 of the The Rules and Regulations of the State of New York (effective April 2005) is entitled "Subsurface sewage treatment systems." Part (a) number 9 states that "all existing subsurface sewage treatment systems, which are operating in accordance with their Federal, State, and local approvals on the effective date of these rules and regulations, but which do not comply with the additional requirements set forth in this section, shall be allowed to continue to operate and shall be considered noncomplying regulated activities. However, if at any time after the effective date of these rules and regulations such subsurface sewage treatment system fails or needs remediation, the owner or operator of the subsurface sewage treatment system shall comply with the following:

(i) Any proposed remediation of any part of such existing subsurface sewage treatment system shall require the prior review and approval of the Department [of Health], and if approved, shall be completed as soon as possible in accordance with a schedule approved by the Department;

(ii) Upon the failure of any subsurface sewage treatment system, it shall be remediated, to the extent possible, in accordance with the design standards set forth in this section, and shall require the prior review and approval of the Department. However, if the Department determines, based upon the application submitted by the owner or operator of the subsurface sewage treatment system, that such system cannot comply with this section, the owner or operator of the subsurface sewage treatment system shall cooperate with the Department to determine the most suitable location and design for the system on the specific site.

The Department may require the owner to agree to a regular schedule for the pump-out of any failed subsurface sewage treatment system; and

(iii) The provisions of this paragraph shall not apply to the routine repair and maintenance of a subsurface sewage treatment system, including, but not limited to, the pump-out of a septic tank, the repair of a broken lateral, the leveling of a distribution box, or the removal of a blockage."

Thus, State regulations include mechanisms for requiring certain upgrades or repairs to subsurface sewage disposal systems, including those in public water supply watersheds.

Orange County Environmental Health Department

This county department is charged with monitoring public water supplies for conformance with NYS Sanitary Code, including tests for water quality, and reviewing proposed improvements. The department essentially administers the state's public health laws regarding water systems and sources. Of the more than 600 public water supply systems in the county, the bureau directly monitors over 250 of the largest systems that include all of the municipalities' water supply systems.

The department also conducts detailed plan reviews of sewage disposal systems at regulated facilities such as food service and temporary residence operations as well as smaller subdivisions submitted to the department. This provides additional protections in public water supply watersheds as the county may be reviewing applications for sewage disposal systems in watersheds.

3.2 Town of Warwick Plans, Policies, and Regulations

Comprehensive Plan

The Town of Warwick Comprehensive Plan was adopted in 2008 and is an update of the previous plans adopted in 1987 and 1999. The plan supports the town's vision, which is to remain an agricultural and residential community and accommodate new growth with minimum impact to the environment.

Section 2.0 of the Comprehensive Plan provides a snapshot of the town of Warwick in 2008. This section addresses Glenmere Lake directly as follows: "Glenmere Lake currently has good water quality although naturally there is some siltation and weed growth in shallow areas. The lake is an extremely important water supply source in that it supplies water for the Village of Florida. Glenmere Lake needs dredging to help slow the eutrophication process. This cannot be done however unless a substitute water source, such as the proposed Black Meadow Creek Reservoir, is developed for the project period. The majority of the land around and to the east of the lake is owned by the County and is undeveloped."

The lake is additionally addressed in Section 2.6 in the context of recreation: "Additional recreational opportunities exist near Glenmere Lake as well as with the new Village of Florida park at Glenmere. The Orange County Comprehensive Plan suggests some of the 1075 acres owned by the County 'may now be considered as future park land.' Glenmere Lake provides such a unique opportunity for recreation development. There are currently plans to develop facilities in this area."

Section 3.0 of the Comprehensive Plan presents a list of goals for several issues. The issues that are germane to public water supply watershed protection (residential development, open space, and environmental protection) are listed below along with the applicable goals. Goals for residential development are to:

- Protect and enhance rural character
- Concentrate dense development in the villages and hamlets
- Stimulate a diversity of housing types
- Encourage a mixed-use pattern of development in the villages and hamlets

Goals for open space and recreation are to:

- Maintain and expand public access to Greenwood Lake and develop access to other waterbodies such as Cascade Lake and Wickham Lake
- Support preservation of open space
- Prepare an Open Space Plan
- Include the public in setting recreational policies

Goals for environmental protection are to:

- Protect environmental sensitive areas
- Ensure that groundwater quality meet Safe Drinking Water Act (SDWA) standards and that an adequate quantity of water is available for future needs
- Protect surface and ground waters from point and nonpoint source pollution
- Protect habitats for flora and fauna diversity
- Protect wetlands

At least one recommendation is presented in the plan for each one of the above goals. One important recommendation of the Comprehensive Plan is to develop and adopt a "Public Water Supply Watershed Overlay District." The district would provide for additional protections relative to stormwater runoff, nutrients, and septic system wastes. Glenmere Lake was suggested as one of the watersheds to include as an overlay district.

Zoning and Subdivision Regulations

The Town of Warwick manages land uses through the Subdivision and Zoning sections of its Town Code, found in Chapters 137 and 164, respectively. Certain elements of these regulations are of interest with regard to watershed management for protection of public water supply. The Planning Board administers the regulations.

The stated purposes of the Zoning Regulations are to:

- Protect and enhance the rural character and quality of life in the Town.
- Support the economic viability of farming.
- Preserve as many of the operating farms as possible.
- Preserve the agricultural heritage of the Town.
- Encourage new development that is compatible with farming activities.
- Concentrate denser residential development around the villages and the hamlets, and maintain rural densities in the remainder of the Town.
- Stimulate a diversity of housing types and increase the stock of affordable homes.
- Encourage a mixed-use pattern of development, where appropriate, in and around the hamlets and adjacent to the villages.
- Assure that the village and hamlet centers remain as the focus for retail and service industry development.
- Provide for commercial development next to existing commercial and industrial uses.
- Encourage alternatives to typical modern highway-oriented commercial development.
- Support small locally owned businesses and retail centers which are in character with the Town's largely rural environment.
- Create a commercial atmosphere friendly to small business and home occupations.
- Maintain and expand public access to Greenwood Lake and develop access to other water bodies.
- Support preservation of open space especially in environmentally sensitive areas.
- Reduce traffic congestion.
- Promote public transit.
- Encourage alternatives to the automobile, such as walking, bicycling and commuter car/van pooling.
- Improve coordination between various means of transportation.
- Allow infrastructure development in areas targeted for growth while maintaining overall density in the Town.
- Protect the natural scenic quality of the Town and environmentally sensitive areas.
- Ensure that groundwater quality meets Safe Drinking Water Act quality standards and that an adequate amount of water will be available to provide for future needs.
- Protect surface and ground waters from point and nonpoint source pollution.
- Protect habitats for the diversity of existing flora and fauna in Warwick.
- Protect wetlands as important environmental resources.
- Use every available mechanism to maximize coordination between the Town and three villages with regard to land use planning, transportation infrastructure, economic development, provision of recreational facilities, expansion of water and sewer facilities, regulation of utility, communication and power franchises, solid waste disposal, and all other aspects of community life.

Many of these goals are consistent with watershed management and the protection of public water supply watersheds. As the largest municipality with land in the Glenmere Lake watershed, this is important.

The zoning districts in the watershed are RU (Rural), MT (Mountain), CO (Conservation), and LB (Local Hamlet Business), described below:

- The purpose of the Rural District is to maintain the town's historic pattern of rural and agricultural settlements characterized by large expanses of open space and unspoiled views from the road, a scattering of residences, farms, and small businesses, and clustered development surrounded by open space. The base density is four acres per dwelling unit.

- The purpose of the Mountain District is to protect the scenic beauty of Warwick's mountainous lands by restricting development that would mar the scenic landscapes of the town's higher elevations and by establishing a density of development appropriate to the thin and fragile soil conditions found there. The base density is five acres per dwelling unit.

- The purpose of the Conservation District is to recognize the environmental sensitivity associated with Mounts Adam and Eve, Warwick, Taylor and Bellvale Mountains, the Appalachian Trail, and significant freshwater wetlands and to restrict large-scale development affecting such areas. The base density is six acres per dwelling unit.

- The purpose of the Local Hamlet Business District is to encourage increased pedestrian-oriented commercial and retail activity in the town's hamlets and create a location where greater flexibility is provided for mixed use of commercial and residential uses within individual structures to provide a variety of housing options and lower business costs.

The required large lot sizes for the RU, MT, and CO zoning districts have inherent abilities to protect or maintain water quality by virtue of the fact that intense development is less likely to occur in the district. The LB district has only a very small overlap with the watershed; thus, development in accordance with this zone can be addressed on a case-by-case basis.

"Cluster developments" are allowable in the RU, MT, and CO districts and have associated "bonus densities" as described in the regulations. A subdivision is considered a cluster subdivision when lots and dwelling units are clustered closer together than otherwise possible in a conventional subdivision and where open space is created on the remainder of the property without increasing density for the tract as a whole. Cluster development is not counter to watershed management and, in fact, it may help protect sensitive areas.

"Conservation density subdivisions" are also allowable in the RU, MT, and CO districts. They encourage the preservation of large tracts of open space by affording flexibility to landowners in road layout and design. Such subdivisions preserve open space by creating lots that average at least two times the minimum size required in the zoning district. This

lower density is maintained in perpetuity through the use of permanent conservation easements and other legally binding instruments. Lots sizes for the RU, MT, and CO districts are 8, 10, and 12 acres, respectively. Such development is not counter to watershed management and, in fact, it may help protect sensitive areas.

The Town of Warwick has an Aquifer Protection Overlay District (AQ-O) to protect, preserve, and maintain the quality and quantity of ground water resources that the town depends upon for present and future public water supply, and for numerous private wells in the town. The AQ-O District consists of aquifers and aquifer recharge areas shown on the zoning map. The district is an approximate delineation of the boundaries of the unconsolidated sand and gravel deposits, recharge areas with sand and gravel at the surface, and probable high-yield bedrock well locations. All applications for subdivision, site plan, or special use permit approval in the overlay shall include an aquifer impact assessment, and a number of land uses are restricted or prohibited. To the extent that this district includes portions of the Glenmere Lake watershed, it may be protective of water quality in the lake.

Other zoning districts are also of interest to watershed management. The "Open Space Preservation District" was designed for situations where it is appropriate to make adjustments to permissible density and area requirements for the specific purpose of preserving open space. An application for an open space preservation project shall address the preservation and enhancement of natural and cultural features of a site; the accommodation of land uses and physical site arrangements that are not contemplated under conventional zoning but which would further the land use conservation and development goals; the creation of usable open space and recreation lands; the preservation of scenic viewsheds, scenic roads, greenway corridors, water resources, forests, meadows, geologic features, environmentally sensitive areas, significant plant and animal habitats, biodiversity, and important ecological resources; and the provision of a more desirable environment than what would be possible through the strict application of existing zoning regulations.

The "Biodiversity Conservation Overlay District" (BC-O) was designed to appropriately manage the town's diverse habitats and natural systems. The Metropolitan Conservation Alliance of the Wildlife Conservation Society provides a tool for identification of such habitats and serves as the basis for the district. The habitat management process is meant to protect the integrity and value of Warwick's natural areas, including the town's watersheds and significant biological resources and streamline the planning review processes by facilitating the New York State Environmental Quality Reviews (SEQR). Use of the habitat assessment process is mandatory for all major subdivisions within the BC-O District.

Additionally, the Town of Warwick may acquire conservation easements over property. The proposed easement shall conserve, preserve and protect an area where one or more of the following are significant: value as agricultural or forest land; unique scenic or natural beauty; value as a watercourse, water body, freshwater wetland, or aquifer recharge area;

unique geological or ecological character; historical, archaeological, architectural, or cultural amenities; value as a community recreational area, greenway corridor, or its relationship to an adjacent recreational area; value as a wildlife habitat or its relationship to an adjacent wildlife preserve or wildlife corridor; intrinsic value as open space necessary to preserve scenic vistas or otherwise enhance community character and attractiveness; and/or intrinsic value as open space in determining future land use development patterns within the town.

One of the consequences of the annexation of land from Warwick by the Village of Florida is the change of the annexed land from a Warwick zoning class to a Florida zoning class. This occurred, for example, with the annexation of land near Glenmere Lake for the proposed Glenmere Preserve development. Subsequent to annexation, the land was zoned Planned Adult Community (PAC) which is described below in Section 3.4. Thus, annexation is one method of changing the allowed density of development in a particular tract of land.

Stormwater management is an important component of the zoning code. Any proposed development must be designed to provide for proper surface water management through a system of controlled drainage that preserves existing drainage patterns, protects other properties and public roadways, and mitigates water quality impacts to the greatest extent practical. To the greatest extent practical, drainage systems shall be designed to avoid an increase in peak stormwater volume and velocity. Objectives of stormwater management include the following:

- Require land development activities to conform to the substantive requirements of the New York State Department of Environmental Conservation State Pollutant Discharge Elimination System (SPDES) General Permit for Construction Activities.
- Minimize increases in stormwater runoff from land development activities in order to reduce flooding, siltation, increases in stream temperature, and streambank erosion and maintain the integrity of stream channels and associated wildlife habitats.
- Minimize increases in pollution caused by stormwater runoff from land development activities which would otherwise degrade local water quality.
- Control the total annual volume of stormwater runoff which flows from any specific site during and following development to the maximum extent practicable.
- Manage stormwater runoff rates and volumes and reduce soil erosion and nonpoint source pollution, wherever possible, through stormwater management practices and ensure that these management practices are properly maintained and eliminate threats to public safety.
- All stormwater should be treated as a valuable resource.
- Ensure that stormwater management basins are always regarded as an aesthetic and environmental asset to the community, as opposed to just a necessity.
- Stormwater design is an integral element of neighborhood design. Engineering elements must not detract from their surroundings or the character of the neighborhood.

- Stormwater management should integrate appropriate civic art so that Warwick can continue to be a thriving and livable rural community.

No application for approval of a land development activity shall be deemed complete until the Planning Board has received a stormwater pollution prevention plan (SWPPP) prepared in accordance with the current State of New York SPDES General Permit for Construction Activities. The Planning Board may require a SWPPP regardless of the area of proposed disturbance. Additionally, all building site development activities within the town of Warwick must have erosion and sediment controls that meet the standards of the most current version of the *New York Guidelines for Urban Erosion and Sediment Control*, printed by the Empire State Chapter of the Soil and Water Conservation Society.

The zoning and subdivision regulations have similarities. The purposes of the subdivision regulations are to ensure the following:

- That land to be subdivided shall be of such character that it can be used safely for building purposes without danger to health or peril from fire, flood or other menace
- That proper provision shall be made for drainage, water supply, sewerage and other needed improvements
- That all proposed lots shall be so laid out and of such size as to be in harmony with the development pattern of the neighboring properties
- That the proposed streets shall compose a convenient system conforming to the Official Map, if such exists, and shall be properly related to the proposals shown on the Master Plan, if such exists, and shall be of such width, grade and location as to accommodate the prospective traffic, to facilitate fire protection and to provide access of fire-fighting equipment to buildings
- That proper provision shall be made for open spaces for parks and playgrounds

The following are required in new subdivisions except as waived by the Planning Board:

- Paved streets
- Curbs or gutters
- Sidewalks
- Water mains and fire hydrants
- Sanitary sewage disposal
- Storm drainage system
- Street signs
- Streetlighting
- Street trees
- Seeding or sodding of planting strips with lawn grass

Paved widths shall be 64, 40, and 30 feet for arterials, collectors, and local streets, respectively. Streets shall be graded and improved with pavements, curbs and gutters, sidewalks, storm drainage facilities, water mains, sewers, streetlights and signs, street trees and fire hydrants (except where waivers may be requested and granted by the

Planning Board). Curbs, gutters, sidewalks, street pavements, fire hydrants, streetlights, shade trees, monuments, water mains, storm sewers, sanitary sewers, and any other improvements that may be required shall be designed and constructed to conform to the specifications as established by resolution or ordinance of the Town Board. Requirements for some of these features may be consistent with watershed management, depending on the design of a particular development.

All subdivisions shall be related to the drainage pattern affecting the areas involved, with proper provision to be made for adequate storm drainage facilities. The applicant may be required by the Planning Board to carry away by pipe or open ditch any spring water or surface water that may exist either previous to or as a result of the subdivision. Such drainage facilities shall be located in the street right-of-way, where feasible, or in perpetual unobstructed easements of appropriate width. A culvert or other drainage facility shall, in each case, be of adequate size to accommodate the potential runoff from the entire upstream drainage area, whether inside or outside the subdivision area. The design and size of this facility shall be subject to the approval of the Municipal Engineer.

A culvert or other drainage facility shall, in each case, be large enough to accommodate potential runoff from its entire upstream drainage area, not only the anticipated discharge from the property being subdivided but also the anticipated runoff that will occur when property at a higher elevation in the drainage basin is developed. The Municipal Engineer shall approve the design and size of facility based on anticipated runoff from the following storm frequencies under conditions of total potential development permitted by the Zoning Ordinance.

Generally, for watersheds with drainage areas of less than 320 acres, all structures should be designed to carry the peak runoff for a 25-year storm. For watersheds with drainage areas of between 320 and 640 acres, the structures should be designed to carry peak runoff for a 50-year storm. For watersheds with drainage areas larger than one square mile, all structures should be designed to carry peak runoff for a 100-year storm. The developer's engineer must submit a report of the effect of each subdivision on the downstream drainage facilities outside the area of the subdivision. This study shall be reviewed by the Municipal Engineer and the Orange County Soil and Water Conservation District. Where it is anticipated that the additional runoff incident to the development of the subdivision will overload an existing downstream drainage facility during a 25-year storm, provision for the rerouting or storage of the increased runoff must be made by the developer.

The above requirements are designed for adequate conveyance of stormwater. Because the application of these requirements will help prevent erosion and resulting sedimentation, they are somewhat protective of water quality. However, conveyance of stormwater can also lead to the movement of nonpoint sources of pollution to watercourses, such that other means of water quality protection may be recommended.

Conservation Board

The Town of Warwick Conservation Board is governed by Chapter 10 of the Town Code. The Conservation Board has a broad array of powers and duties that are of interest to watershed management, including the following:

- Advise the Town Board on matters affecting the preservation, development, and use of the natural and man-made features and conditions of the town so as to enhance the long-range value of the environment to the people of the town.
- Develop and conduct a program of public information in the community to foster increased understanding of the nature of environmental problems and issues.
- Conduct studies, surveys, and inventories of the natural and man-made features within the town.
- Maintain an inventory or index of all open spaces in public or private ownership within the municipality, and of the ownership, present use, and proposed use of such open areas, so as to provide a base of information for recommendations by the Conservation Board for their preservation and/or use.
- Seek to coordinate, assist, and unify the efforts of private groups, institutions, and individuals with the Town of Warwick.
- Maintain liaison and communications with public and private agencies and organizations of local, state, and national scope whose programs and activities have an impact on the quality of the environment or who can be of assistance to the Conservation Board.
- Further assist the town in the development of sound open-area planning and assure preservation of natural and scenic resources on the local level by reviewing each application received by the Town Board or by the Building Department, Zoning Board, Planning Board, or Board of Appeals that seeks approval for the use or development of any open area listed in the open space index; and submitting a written report to the referral body to evaluate the proposed use or development of the open area in terms of the open-area planning objectives of the municipality and include the effect of such use or development on the open space index. The report shall make recommendations as to the most appropriate use or development of the open area.

Community Preservation Project Plan (CPPP*)*

The Town of Warwick is enabled to establish a Community Preservation Fund supported by revenues from a 0.75% real estate transfer tax. This legislation allows the Town of Warwick to protect its farmland and open space. Chapter 54 of the Warwick Code is entitled the "Agricultural and Open Space Preservation and Acquisition program."

One of the key elements supporting the adoption and implementation of the Town of Warwick Community Preservation Fund is the Community Preservation Project Plan (CPPP). The CPPP serves to build upon the Comprehensive Plan and Zoning Law as well as any new initiatives. The CPPP is meant to list every project that the town plans to undertake pursuant to the Community Preservation Fund, list every parcel in the town that should be preserved, and provide for a detailed evaluation of all available land use

alternatives to protect community character, including but not limited to fee simple acquisition, zoning regulations, transfer of development rights, purchase of development rights, incentive zoning, and conservation easements.

The Town of Warwick participated in an intermunicipal biodiversity study of the Southern Wallkill region of Orange County. The study identified the Glenmere Lake/Black Meadow Creek area as "important for biodiversity" as it supports a "population of a rapidly declining amphibian species." The CPPP lists a number of parcels associated with Glenmere Lake as summarized in Table 3-2 below.

TABLE 3-2
Parcels Associated with Glenmere Lake

Identifier	Tax Map Parcel	Area (acres)
Projects in the Agricultural Protection Overlay (APO)		
APO/PW-GLEN	33-1-20.3	175.9 acres
APO/PW-GLEN	33-1-21	200.1 acres
APO/PW-GLEN	33-1-22	84.4 acres
APO/PW-GLEN	33-1-30.22	35.1 acres
APO/PW-GLEN	33-1-62	108.4 acres
APO/PW-GLEN	35-1-56.22	119.5 acres
For the Freshwater Wetlands and Biodiversity Conservation Target Areas		
FW&B/PW-GLEN	9-1-7	95.1 acres
For the Public Water Supply Watersheds Target Area		
PW-GLEN	23-1-28.2	182.4 acres
PW-GLEN	23-1-29	32.8 acres
PW-GLEN	9-1-13	31.7 acres
PW-GLEN	9-1-14	30.0 acres
PW-GLEN	9-1-15	35.1 acres
PW-W/GLEN	23-1-2	152.2 acres

3.3 Town of Chester Plans, Policies, and Regulations

Zoning and Subdivision Regulations

The Town of Chester manages land uses through the Subdivision and Zoning sections of its Town Code, found in Chapters 83 and 98, respectively. Certain elements of these regulations are of interest with regard to watershed management for protection of public water supply. The Planning Board administers the regulations.

The stated purposes of the Zoning Regulations are to:

- Facilitate the efficient and adequate provision of public facilities and services
- Assure adequate sites for residences, industry, and commerce
- Prevent and reduce traffic congestion so as to promote efficient and safe circulation of vehicles and pedestrians
- Gradually eliminate nonconforming uses

- Encourage flexibility in the design and development of land in such a way as to promote the most appropriate use of lands, to facilitate the adequate and economical provision of streets and utilities, and to preserve the natural and scenic qualities of open lands
- Preserve and protect viable agricultural land, streams, ponding areas, floodplains, reservoirs, and watersheds
- Assure adequate separation between uses and buildings so as to promote safety, comfort, privacy, and the preservation of property values

Many of these goals are consistent with watershed management and the protection of public water supply watersheds. The only district in the watershed is AR-3, Agricultural-Residential District. The required large lot size for this zoning district has inherent abilities to protect or maintain water quality by virtue of the fact that intense development is less likely to occur in the district. However, it is recognized that only a small portion of Chester is within the Glenmere Lake watershed, such that limited development pressures would be expected to arise.

The Planning Board is authorized to approve cluster developments similar to the Town of Warwick. The cluster development shall in no case result in a permitted number of building lots or dwelling units that exceeds the number that could be permitted if the land were subdivided into lots conforming to the minimum lot size and all other applicable requirements pertaining to the district or districts in which the land is situated. Cluster development is not counter to watershed management and, in fact, it may help protect sensitive areas.

The Town Highway Superintendent and the Town Engineer are the "Stormwater Management Officers" for the town and must review all stormwater pollution prevention plan submissions. Each application for land development shall be accompanied by a stormwater management plan or statement of exemption that shall be certified as conforming to the requirements of this section by a licensed professional engineer. Applicants are required to submit a SWPPP or statement of exemption to the Stormwater Management Officer.

The zoning and subdivision regulations have similarities. The purpose of the subdivision regulations is to ensure the orderly, efficient, and economical development of the town. This means, among other things, that land to be subdivided shall be of such character that it can be used safely for building purposes without danger to health or peril from fire, flood, or other menace; that proper provision shall be made for drainage, water supply, sewerage, and other needed improvements; that all proposed lots shall be so laid out and of such size as to be in harmony with the development pattern of the neighboring properties; that the proposed streets shall compose a convenient system conforming to good planning practice and the Official Map, if such exists, and shall be properly related to the proposals shown on the Comprehensive Plan and shall be of such width, grade, and location as to accommodate the prospective traffic, to facilitate fire protection, and to

provide access of fire-fighting equipment to buildings; and that proper provision shall be made for open spaces for parks and playgrounds or fees in lieu thereof.

The subdivision regulations ensure that the highest standards of site, building and landscape design are conscientiously met through the use of qualified technical and aesthetic judgment compatible with the Comprehensive Plan. The Planning Board shall require that lands be adequately drained and the streets have sufficient width and suitable grade and locations to accommodate the traffic and to provide access for fire-fighting equipment to buildings. Required improvements shall be designed and constructed to conform to the specifications as established by the town. Similar to the Town of Warwick, the following are required except when waived by the Planning Board:

- Paved streets
- Curbs or gutters
- Sidewalks
- Water mains
- Sanitary sewage disposal
- Storm drainage
- Street signs
- Street trees
- Seeding or sodding of planting strips with lawn grass where sidewalks have been required
- Underground utilities on private lots and for all public and private streets which do not have existing utility lines

Paved widths for streets shall be 40, 30, 24, and 20 feet for collector, suburban, rural, and private roads, respectively. Streets shall be graded and improved with pavements, curbs and gutters, sidewalks, storm drainage facilities, water mains, sewers, streetlights and signs, street trees and fire hydrants, except where waivers may be requested, and the Planning Board may waive, subject to appropriate conditions, such improvements as it considers may be omitted without jeopardy to the public health, safety, and general welfare. Curbs, gutters, sidewalks, street pavements, fire hydrants, streetlights, shade trees, monuments, water mains, storm sewers, sanitary sewers and any other improvements that may be required shall be designed and constructed to conform to the specifications as established by the Planning Board. Requirements for some of these features may be consistent with watershed management, depending on the design of a particular development.

All subdivisions shall be related to the drainage pattern affecting the areas involved with proper provision to be made for adequate storm drainage facilities. The developer may be required by the Planning Board to carry away by pipe or open ditch any spring water or surface water that may exist either previous to or as a result of the subdivisions. Such drainage facilities shall be located in the street right-of-way where feasible or in perpetual unobstructed easements of appropriate width. A culvert or other drainage facility shall in each case be of adequate size to accommodate the potential runoff from the entire

upstream drainage area, whether inside or outside the subdivision area. The design and size of this facility shall be in conformance with specifications contained herein and shall be subject to the approval of the Planning Board Engineer.

As with the Town of Warwick, all structures should be designed to carry the peak runoff for a 25-year storm for watersheds with drainage areas of less than 320 acres. For watersheds with drainage areas of between 320 and 640 acres, the structures should be designed to carry peak runoff for a 50-year storm. For watersheds with drainage areas larger than one square mile, all structures should be designed to carry peak runoff for a 100-year storm. All pipes shall be of diameter 18 inches or greater. The developer's engineer must provide a report of the effect of each subdivision on the existing downstream drainage facilities outside the area of the subdivision; this study shall be reviewed by the Planning Board Engineer and may be referred to the Orange County Soil and Water Conservation District. Where it is anticipated that the additional runoff incident to the development of the subdivision will overload an existing downstream drainage facility during a 25-year storm, on-site stormwater management or storage of the increased runoff shall be provided by the developer. In calculating anticipated runoff, the results shall meet or exceed those that are computed by the method approved by the Soil Conservation Service of the United States Department of Agriculture.

The above requirements are designed for adequate conveyance of stormwater. Because the application of these requirements will help prevent erosion and resulting sedimentation, they are somewhat protective of water quality. However, conveyance of stormwater can also lead to the movement of nonpoint sources of pollution to watercourses, such that other means of water quality protection may be recommended.

Wetland Regulations

The Town of Chester is the only watershed municipality with separate wetland ordinances. The ordinance dates back to 1976. Chapter 54 of the Town Code sets the wetland regulations as follows: "It is declared to be the public policy of the Town of Chester to preserve, protect and conserve freshwater wetlands and the benefits derived therefrom, to prevent the despoliation and destruction of freshwater wetlands and to regulate the development of such wetlands in order to secure the natural benefits of freshwater wetlands, consistent with the general welfare and beneficial economic, social and agricultural development of the Town."

Any person proposing to conduct or cause to be conducted a regulated activity requiring a permit under Chapter 54 upon any freshwater wetland or adjacent area shall file an application for a permit with the Inspector. In granting, denying, or conditioning any permit, the agency shall consider the effect of the proposed activities with reference to the public health and welfare; fishing; flood, hurricane, and storm dangers; and protection or enhancement of the several functions of the freshwater wetlands and the benefits derived from them. A permit shall not be granted unless the proposed activity is consistent with the policy of Chapter 54 to preserve, protect, and conserve freshwater

wetlands, and the benefits derived therefrom, to prevent the despoliation and destruction of freshwater wetlands and to regulate the development of such wetlands in order to secure the natural benefits of freshwater wetlands, consistent with the general welfare and beneficial economic, social, and agricultural development of the town of Chester.

3.4 Village of Florida Plans, Policies, and Regulations

Comprehensive Plan

The Village of Florida Comprehensive Plan was adopted in 2002. The plan lists eight main goals as follows:

1. Plan for and provide additional adequate recreation areas and facilities for the residents of the village
2. Main an annual growth rate of not more than 2%
3. Maintain the present quality of life
4. Facilitate efficient and adequate planning and development of public facilities and services within the budgetary constraints of the village
5. Maintain a stable economy and tax base for the residents and businesses in the village
6. Prevent the level of services from diminishing while allowing for increased costs within current inflation rates
7. Prevent increases in traffic congestion
8. Expand and control the land around the village reservoir for the protection of the village's water supply and its residents

Goal #8 directly addresses Glenmere Lake. Goal #1 indirectly addresses the lake as the village maintains a public park along the west shore of the lake. The plan describes the annexation of 97 acres for the lakeside park subsequent to its purchase from the county.

Section IV, number 2 of the Comprehensive Plan addresses watershed protection. The plan notes that watershed rules and regulations can protect the reservoir from future development and some pollutants, but they cannot protect it from some existing conditions. Additionally, the plan notes that roads allow for oils to enter the watershed system. The plan also notes that as future development occurs along with new EPA stormwater regulations, "it is hoped that these regulations will assist in reservoir protection."

Zoning and Subdivision Regulations

The Village of Florida manages land uses through the Subdivision and Zoning sections of its Village Code, found in Chapters 103 and 119, respectively. Certain elements of these regulations are of interest with regard to watershed management for protection of public water supply.

The stated purposes of the zoning regulations are to provide for the following:

- The facility of the efficient and adequate provision of public facilities and service
- The assurance of adequate sites for residence, commerce, industry, and related uses
- The provision of privacy for families
- The prevention and reduction of traffic congestion
- The maximum protection of residential areas
- The gradual elimination of nonconforming uses
- The enhancement of the appearance of the village of Florida as a whole

The only zoning district in the Glenmere Lake watershed is RR, the Rural Residence District. A lot must have an area of 40,000 square feet per dwelling. The required large lot size has inherent abilities to protect or maintain water quality by virtue of the fact that intense development is less likely to occur in the district. However, it is recognized that only a small part of the watershed lies within the village boundaries.

"Cluster" developments and "Planned Adult" communities are allowed in the RR District, subject to their applicable standards. A cluster development shall result in a permitted number of building lots or dwelling units that does not exceed the number which could be permitted if the land were subdivided into lots conforming to the minimum lot size and density requirements of the underlying zoning district. Open space preservation in cluster developments is regulated by the Planning Board, which may establish such conditions on the ownership, use, and ongoing maintenance of such open lands. Thus, cluster development is not counter to watershed management and, in fact, it may help protect sensitive areas.

The Planned Adult Community (PAC) District was established to enable the village to permit planned unit development intended to primarily house people 55 years of age and older. The PAC District permits the village to evaluate the need and demand for a PAC; address specific aspects of the PAC; relate the type, design, and layout of a PAC to a particular site; and control the impacts that such development may have on the surrounding community. Furthermore, the PAC District is intended to discourage sprawl while encouraging "innovative, traditional neighborhood developments and alternative land development practices" that will otherwise promote public health, safety, and welfare; preserve or enhance property values within existing residential areas; and maintain the unique character of the village. Thus, this type of development is not necessarily counter to watershed management, depending on the design of a particular development.

Like zoning, the subdivision of land is administered by the Planning Board. The purpose of the regulations is to ensure the "orderly, efficient, coordinated and economical development of the Village and affording adequate facilities for the housing, transportation, distribution, comfort, convenience, safety, health and welfare of its population." This means the following:

- That land to be subdivided shall be of such character that it can be used safely for building purposes without danger to health or peril from fire, flood, or other menace
- That proper provision shall be made for the preservation of natural assets such as streams, ponds, trees, etc., drainage, water supply, sewerage, and other needed improvements
- That all proposed lots shall be so laid out and of such size as to be in conformance with the Zoning Law and in harmony with the development pattern of the neighboring properties
- That the proposed streets shall compose a convenient system… and shall be of such width, grade, and location as to accommodate the prospective traffic, to facilitate fire protection, and to provide access of fire-fighting equipment to buildings
- That proper provision shall be made for open spaces for parks and playgrounds
- Recognition of a desirable relationship of the land form, its topography, and geology, to natural drainage and surface water runoff and to the ground water table
- Encouragement of variety and flexibility in residential development provided for in the Zoning Law, including clustering of lots

Various sections of the regulations ensure that the highest standards of site, building, and landscape design are met through the use of technical and aesthetic judgment compatible with the Community Master Plan of the village. The Planning Board shall require that the subject land be adequately drained and the streets shall be of sufficient width and suitable grade and suitably located to accommodate the prospective traffic and to provide access for fire-fighting equipment to buildings. The Planning Board shall further require that all lots shown on the plats shall be adaptable for the intended purposes without danger from flood, fire, or erosion. Required improvements shall be designed and constructed to conform to the specifications as established by the village. The following are required except when waived by the Planning Board:

- Paved streets
- Curbs or gutters
- Sidewalks
- Water mains
- Sanitary sewage disposal
- Storm drainage
- Street signs
- Street lighting
- Street trees
- Seeding or sodding of planting strips with lawn grass
- Fire pull boxes

Paved widths shall be 64, 40, and 30 feet for arterials, collectors, and local streets, respectively. Streets shall be graded and improved with pavements, curbs and gutters, sidewalks, storm drainage facilities, water mains, sewers, streetlights and signs, street trees and fire hydrants, except where waivers may be requested, and the Planning Board may waive, subject to appropriate conditions, such improvements as it considers may be

omitted without jeopardy to the public health, safety, and general welfare. Curbs, gutters, sidewalks, street pavements, fire hydrants, streetlights, shade trees, monuments, water mains, storm sewers, sanitary sewers, and other improvements that may be required shall be designed and constructed to conform to the specifications as established by resolution or ordinance of the Village Board. Requirements for these features may be consistent with watershed management, depending on the design of a particular development. As stated above, only a small part of the Glenmere Lake watershed lies within the village boundaries.

Subdivisions shall be related to the drainage pattern affecting the areas involved, with proper provision to be made for adequate storm drainage facilities. The subdivision may be required by the Planning Board to carry away by pipe or open ditch any spring or surface water that may exist either previous to or as a result of the subdivision. Such drainage facilities shall be located in the street right-of-way, where feasible, or in perpetual unobstructed easements of appropriate width. A culvert or other drainage facility shall be of adequate size to accommodate the potential runoff from the entire upstream drainage area, whether inside or outside the subdivision area. The developer's engineer shall submit a written report on the effect of each subdivision on the existing downstream drainage facilities outside the area of the subdivision; this study shall be reviewed by the Village Engineer and the Orange County Soil and Water Conservation District. The design and size of this facility shall be subject to the approval of the Village Engineer.

A culvert or other drainage facility shall, in each case, be large enough to accommodate potential runoff from its entire upstream drainage area, not only the anticipated discharge from the property being subdivided but also the anticipated runoff that will occur when property at a higher elevation in the drainage basin is developed. Generally, for watersheds with drainage areas of less than 320 acres, all structures should be designed to carry the peak runoff for a 25-year storm. For watersheds with drainage areas of between 320 and 640 acres, the structures should be designed to carry peak runoff for a 50-year storm. For watersheds with drainage areas larger than one square mile, all structures should be designed to carry peak runoff for a 100-year storm. Where it is anticipated that the additional runoff incident to the development of the subdivision will overload any existing downstream drainage facility during a 25-year storm, provision for the storage of the increased runoff must be made by the developer.

The above requirements are designed for adequate conveyance of stormwater. Because the application of these requirements will help prevent erosion and resulting sedimentation, they are somewhat protective of water quality. However, conveyance of stormwater can also lead to the movement of nonpoint sources of pollution to watercourses, such that other means of water quality protection may be recommended.

4.0 MANAGEMENT STRATEGIES

4.1 Water Supply Protection and Management Strategies

Glenmere Lake hosts high quality water, wetlands, and ecological habitat. Historically, the potential for water quality degradation has been low largely as a result of the light development in the watershed. Existing management of the watershed and the lake has worked well relative to providing a safe drinking water supply, but additional management and monitoring is warranted as the lake is the sole source of water supply to the village of Florida. Future degradation of the lake would be detrimental to all of its functions, from water supply to recreation to provision of habitat to an endangered species.

Review of Safe Yield and Withdrawals

Glenmere Lake provides approximately 300,000 gpd of drinking water supply in the winter months and up to 700,000 gpd in the summer. The average daily demand in the year 2010 was 473,044 gpd. Several analyses of safe yield have been performed since the 1960s. A 1967 report described the dependable yield of Glenmere Lake to be 0.6 mgd, and a 1993 study (supported by a bathymetric survey) determined a safe yield of 0.5 mgd, with a total storage volume of almost 500 million gallons at elevation 533 feet.

The Orange County Water Authority further clarified the safe yield of Glenmere Lake in the year 2000 to be 0.525 mgd when the reservoir elevation is above a rule curve and 0.460 mgd when the elevation is below the curve. The August 2010 Final Draft of the Orange County, New York *Water Master Plan* notes that the available supply for the village of Florida is 0.6 mgd from Glenmere Lake.

Based on the watershed size of 2.5 square miles and an annual precipitation of 45 inches, almost one billion gallons of water falls in the Glenmere Lake watershed each year. With roughly half of that volume evaporated and evapotranspired, an average of 2.7 mgd remains in the watershed and is withdrawn for drinking water or spills over the dam. A safe yield of 0.5 mgd represents 19% of the available water whereas the safe yield of 0.6 mgd represents 22% of the available water. These are annualized averages that do not take seasonality into account.

Based on its surface area of 327 acres and a depth ranging from less than two feet to nearly 11 feet, the previously reported volume of 500 million gallons is believed reasonable for Glenmere Lake. The upper foot of water in the lake holds approximately 100 million gallons, neglecting the space taken up by submerged and emergent aquatic vegetation. During a typical year, the 120 days from May/June through August/September are characterized by evapotranspiration exceeding basin recharge. During this time, one could conservatively assume that the volume of water stored in Glenmere Lake is solely responsible for sustaining public water supply withdrawals. At a safe yield of 0.5 mgd projected over 120 days, 60 million gallons would be withdrawn.

This is 60% of the volume of water held in the upper foot of the lake, indicating that lake drawdown would not reach or exceed one foot.

Recall from Section 2.9 that the Village of Florida Comprehensive Plan states that the lake level has never dropped more than two feet. This is consistent with the calculation that the upper foot of water could sustain withdrawals equal to the safe yield for 120 days without any basin recharge.

Although the reported safe yields for Glenmere Lake are not out of line with the water budget of the watershed, an updated calculation of safe yield is advisable. A new safe yield analysis should attempt to include and account for some of the following, if practical:

- The 1993 bathymetric mapping with a reasonable reduction for the volume of water displaced by aquatic vegetation
- Stream inflows based on actual measurements, a nearby gauging station, or the most recent regression equations developed for the region
- Reasonable releases to Browns Creek downstream of the dam
- A limit on lake level drawdown

The releases to Browns Creek and the limit on lake level drawdown would help allocate water in the drainage basin to biological communities, such as the desired aquatic plants in the southern part of the lake, the Northern cricket frog, and fisheries resources.

Another important consideration related to safe yield is "margin of safety." The margin of safety is the ratio of safe yield (or available water) to daily demand. In order to properly evaluate margin of safety to ensure that the safe yield is sufficient, the population growth of the Village of Florida should be re-evaluated in the context of proposed and pending residential developments.

Glenmere Lake is the sole source of public water supply for the village of Florida and customers in Goshen and lacks source redundancy. Whether a revised safe yield analysis determines that the Glenmere Lake yield is appropriately balanced with public water system demands or imbalanced relative to system demands, the village of Florida would be well served to have access to a redundant supply. An interconnection with another water utility such as the Goshen public water system could provide backup supply to the Florida system in the event that Glenmere Lake were to become compromised due to quantity or quality concerns.

Total Organic Carbon/Disinfection Byproducts

The Village of Florida monitors disinfection byproducts in the public water system as required by Stage 1 of the EPA's Disinfection Byproducts Rule. Disinfection byproducts include TTHM and HAA5. These compounds are formed in systems that use chlorine for disinfection when water age and other factors such as pH allow chemical reactions

between chlorine and organic materials in the water. High levels of disinfection byproducts can indicate that raw water contains high levels of TOC and that water age is excessive in parts of the system.

In 2010, TTHM levels ranged from 36.6 ug/L to 112.4 ug/L, and HAA5 levels ranged from 22.1 ug/L to 81.6 ug/L depending on the month and sample location in the system. Similar ranges were detected in the year 2009. The MCLs for TTHM and HAA5 are 80 ug/L and 60 ug/L, respectively. The occasional elevated levels of TTHM and HAA5 may indicate that TOC is relatively high in Glenmere Lake. Elevated TOC is consistent with the suspended organic matter in the water column, verified by the secchi disc observations described in Section 2.0.

Violations did not occur because Stage 1 of the Disinfection Byproducts Rule requires that systemwide averages be compared to the MCLs. However, implementation of Stage 2 of the Disinfection Byproducts Rule is underway. Compliance with the MCLs for TTHM and HAA5 will be calculated for specific monitoring locations in the distribution system. This approach, referred to as the locational running annual average (LRAA), differs from Stage 1 requirements that determine compliance by calculating the running annual average of samples from all monitoring locations.

The Stage 2 rule requires a system to determine if it has exceeded an operational evaluation level, which is identified using their compliance monitoring results. The operational evaluation level provides an early warning of possible MCL violations, which allows the system to take proactive steps to remain in compliance. A system that exceeds an operational evaluation level is required to review operational practices and submit a report to the state that identifies actions that may be taken to mitigate future high disinfection byproduct levels. Corrective actions to address high levels of disinfection byproducts could range from simple, quickly implemented management or operational changes to major construction.

Based on its service area population, the Florida water system will likely need to comply with Stage 2 commencing in 2013. Therefore, the next 12 months are a critical time for the Florida system to begin making any potential necessary changes to ensure compliance. Management of TOC in the water entering the water treatment plant will be an important component of managing disinfection byproducts, along with managing water age in the distribution system. One of the components of managing TOC is the management of aquatic vegetation.

Other Water Supply Considerations

A large focus of the Village of Florida's water supply protection strategy has centered on the control of aquatic vegetation. This is explored in the following sections. Continued protection of the water supply through sound watershed management land use practices is also explored in the ensuing discussion. These plan elements are common to protection of the water supply but are also critically important to the protection of the habitat

provided by the lake and represent sound watershed management practices in any environment.

4.2 Aquatic Vegetation Management Strategies

Chemical Application

Chemicals such as herbicides are available nationwide for controlling aquatic vegetation, and other chemicals are available for controlling algae. Copper sulfate has been routinely applied to Glenmere Lake to control algae. More recently, a proposal to use the herbicide Sonar in Glenmere Lake has caused some controversy. As noted earlier in this report, the NYSDEC agreed to provide funds for applying Sonar to reduce the amount of Eurasian water milfoil in Glenmere Lake. The active ingredient in Sonar is fluridone.

Although fluridone is approved by the EPA for use in drinking water supplies for controlling aquatic plants, the EPA has not established an MCL for fluridone in drinking water. Fact sheets regarding fluridone are available from some state agencies. The Washington State Department of Health (2000) produced a concise information sheet about fluridone. According to the sheet, "the Sonar label prohibits application to water within ¼ mile of functioning potable water intakes unless the treatment rate is 20 ppb or less. Estimated human exposure from daily consumption of water with 20 ppb of fluridone is 10,000-fold less than the no effect level in test animals. People who wish to avoid even minimal residues can do so by filtering their drinking water with a charcoal-based filter."

Chemical applications to public water supply reservoirs are regulated by most states through the state's environmental protection agency, the state's drinking water agency, a single agency that manages both, or in some cases the two agencies. However, there are differences in these regulations. In New York, fluridone is approved for use in public water supply reservoirs subject to certain conditions. On the other hand, in Connecticut, fluridone cannot be applied to vegetation within ¼ mile of a public water supply reservoir (Connecticut Department of Environmental Protection and Connecticut Department of Public Health, 1994), which means that it cannot be applied directly to a public water supply reservoir. Massachusetts does not appear to ban the use of fluridone in surface water supplies (ENSR, 2005) although its use is not believed to be common in Massachusetts reservoirs.

For the Village of Florida, protection of public health should be the primary objective of managing Glenmere Lake as the sole source of supply for the public water system. Application of chemical controls to the lake or its watershed is at odds with the protection of public health. It is understood that chemical controls may reduce vegetation and thus help reduce TOC. However, any chemical applied to the source of supply would have the potential for passing through the multiple barriers of the treatment system to reach consumers. Therefore, even if the use of chemical controls were found to reduce TOC at

the intake to the water treatment plant, the benefit (a corresponding decrease in disinfection byproducts) may not outweigh the drawbacks.

The potential for significant negative impacts associated with Sonar application strongly suggest that Sonar should not be applied to Glenmere Lake. Both wildlife and water system users could be negatively affected. Although the potential effects of Sonar on wildlife such as the Northern cricket frog are beyond the scope of this study, amphibians are known to be affected by impaired water quality. Therefore, the risk of impact to this rare species is a potential cost that outweighs the potential benefit of vegetation reduction. Furthermore, the potential for migration of fluridone into the public water system is not an acceptable risk to public health at the present time, especially given the lack of an MCL for fluridone. It is understood that EPA allows the use of fluridone in public water supply reservoirs, but individual states such as Connecticut have not permitted its use in public water supplies. Therefore, a precedent exists for discouraging the use of fluridone in reservoirs.

Copper sulfate is approved for use in public water supply reservoirs in many states, including New York and adjacent states such as Connecticut and Massachusetts. Because copper sulfate is already applied to the northern portion of Glenmere Lake, its discontinuation is not supported by the findings of this plan.

Nevertheless, the Village of Florida is encouraged to reduce the frequency and concentrations of the copper sulfate applications to the extent possible. It is important to note that copper sulfate is not effective for control of water milfoil. Rather, it is typically used to control algae. The current frequency and rate of its application may have been appropriate for controlling algae, but opportunities to reduce its usage should be investigated because any chemical added to the water supply has a potential to enter the drinking water system. The village may consider testing a lower application rate at some point in the near future to evaluate the effects, if any. If algae can be controlled with lower copper sulfate applications, that would be desirable. If aeration (discussed below) is ultimately selected as a water quality management strategy, application of copper sulfate may not be necessary.

Evaluation of Aeration

Adequate levels of DO are very important for a water body to support aquatic biota. The amount of DO in water is affected by temperature and atmospheric pressure but also by mineral and nutrient content of the water and the amount of water mixing occurring. The three main sources of DO in an aquatic environment are direct diffusion from the atmosphere, wind and wave action, and photosynthesis. Warmer temperatures, low atmospheric pressure, overabundance of organic matter, and increased mineral and nutrient contents result in decreasing levels of DO.

Thermal stratification also has an impact on DO levels. Typically, DO levels in heavily vegetated, eutrophic lakes drops to nearly zero near the sediment-water interface in the

hypolimnion and lower metalimnion. This is due to increased bacterial processes and oxidative processes associated with the decomposition of organic matter. DO levels near zero were observed at the deepest zones of Glenmere Lake. This oxygen deficit tends not to occur in the epilimnion because of wind effects mixing and aerating the surface water.

The Village of Florida has expressed an interest in adding aerators to Glenmere Lake to improve water quality and prevent further encroachment of the area near the water treatment plant intake by vegetation. According to a conceptual design report prepared by Gooneybird Sales, LLC, "the inveration system will destratify the lake and prevent further intrusion of nuisance weeds without consequence to the Northern cricket Frog, which is known to be in abundance in Glenmere Lake." The proposed aeration system was reportedly designed to keep suspended algal growth and weed fragments from being drawn into the water treatment plant intake pipe. It is important to note that the Village of Florida has not requested continuing assistance from Gooneybird Sales, although the company has continued to update and modify its conceptual design through the year 2011.

Aerators have long been used for a variety of water quality purposes. Such devices are typically used by fisheries managers to promote healthy levels of DO for aquatic biota in reservoirs, lakes, and streams. Increased levels of DO are particularly useful near the sediment-water interface where biochemical oxygen demands (for breaking down organic material) are highest. In addition, they are used to create circulation patterns in small ponds. The movement of water generated by aerators helps to keep sediments in a suspended state, slowing the accumulation of organic sediments (and nutrients) that will support aquatic vegetation.

Temperature monitoring by MMI shows that only part of the lake was thermally stratified in June, namely the deeper portion in the northern area of Glenmere Lake, and the stratification was relatively weak as compared to deeper lakes. The remainder of the lake had temperatures that generally decrease linearly with depth, indicating a lack of stratification. By August, stratification was lacking throughout.

There are several potential factors when considering aeration of Glenmere Lake. These include the proposed location of the aerators, the strength of the aerators, the effects to aquatic fauna, the effects to aquatic flora, and the effects to the water supply system that is reliant on the lake. These are discussed below.

- Proposed Location of the Aerators – Based on the conceptual mapping prepared by Gooneybird Sales, LLC, aeration is currently proposed in three areas on Glenmere Lake. The first area is nearest to the water treatment plant in the northern area of the lake, which includes sample sites GL-1 through GL-4. The second area proposed is just southwest of GL-4. The third area proposed is in the vicinity of GL-5. The highest priority is considered to be Area One, followed by Area Two and Area Three if necessary.

- Area One: This area is the least vegetated area of Glenmere Lake. Based on the sampling performed by MMI, this area contains relatively high levels of DO in the upper part of the water column (greater than 7.0 mg/L) with lower DO available below eight feet in depth. Locating aerators here would provide additional DO to this bottom layer, potentially improving the amount of oxygen available for breakdown of organic material. Aeration could also potentially erase the weak thermal stratification present in this layer, which combined with increased sediment suspension could reduce the amount of nutrients available to vegetation in Glenmere Lake. Over time, these factors may result in less vegetation in the northern part of the lake near the water treatment plant.

- Area Two: This area is relatively unvegetated and is generally similar to Area One with respect to DO and stratification. Based on the sampling performed by MMI, this area has low DO levels at depths below four feet, an indication of increased biochemical oxygen demand at the sediment-water interface. Aerating this area would potentially increase the positive benefits discussed for Area One.

- Area Three: This area has slightly more vegetation present than the previous two, primarily in the shallower zones along the shoreline. Benefits (as described under Area One) would occur at shallower depths and potentially have the benefit of reduction in vegetation. However, Gooneybird Sales, LLC reports that this area does not appear to have electricity available to run the aerators.

- Strength and Layout of the Aerators – Since DO in water has a saturation point based primarily on temperature and pressure and the DO in the three areas is fairly saturated throughout most of the water column but noticeably reduced near the sediment-water interface, aeration will have the most effect on DO levels in the deepest zones of Glenmere Lake. Thus, having a wide distribution of aeration piping would likely have the greatest effect. Since an aeration project would have upfront costs as well as annual operating costs in terms of electricity and maintenance, it is in the village's interest to determine the range and strength necessary to accomplish the stated goals for the aeration project without overdesigning the system.

- Potential Effects to Fisheries Habitat – Given the fact that the upper zones of the water column throughout the northern and central parts of Glenmere Lake have suitable DO levels for fish, aeration is not likely needed to enhance fisheries habitat. Increasing the DO would not be expected to have a negative impact on the quality of fisheries habitat, and it could increase the range of suitable habitat in deeper areas of the lake.

- Potential Effects to Aquatic Flora – Aquatic plants rely on carbon dioxide and sunlight for photosynthesis and nutrients to sustain growth. Such plants are also a source of DO for Glenmere Lake. Aeration will not directly affect flora but will potentially reduce the nutrient supply to aquatic plants by introducing oxygen to areas of the sediment-water interface with low DO (increasing the speed of breakdown of

organic materials) and causing a circulatory flow in the lake that will keep sediments (and nutrients) in suspension. A member of the Greenwood Lake Commission noted during the second public meeting for this Glenmere Lake plan that aeration has not appeared to harm lilies in Greenwood Lake.

- Potential Effects to Water Supply – As Glenmere Lake is used for water supply, any adjustments to the raw water supply are of concern. Operators of the water system have concerns related to TOC levels and the intake of plant fragments into the treatment system. Over time, it is possible that the amount of vegetation in the lake will be reduced in the vicinity of the intake. However, floating plant fragments will likely continue to be an issue in the lake. While the levels of carbon in the lake are currently unknown, the suspension of nutrients may have little impact on the overall TOC levels in the lake. This issue merits additional study.

- Potential Effects to Waterfoul Communities – Several members of the advisory committee have noted that a lake that is aerated year-round will attract Canada geese because the surface of the lake will not freeze. This is not a desired outcome for Glenmere Lake, as the attraction of Canada geese will lead to poor water quality, potential introduction of non-native aquatic plants, and other related problems. Any aeration plan for Glenmere Lake will need to include winter shut-down of the aeration system.

In general, there does not appear to be a compelling reason for aeration in Glenmere Lake. Aeration may not provide the most cost-effective management strategy for Glenmere Lake as the benefits may not justify the costs. Further research and/or analysis are necessary to fully understand the potential benefits and impacts of such a system on the floating algae, vegetation, and water quality in Glenmere Lake. Positive or negative effects of aeration on the Northern cricket frog have not been evaluated as part of the subject Watershed Management Plan.

Control of Eurasian Water Milfoil

The presence of native Northern water milfoil and other submerged aquatic plant species in the vicinity of the water treatment plant intake is undesirable from a water supply perspective. The presence of Eurasian water milfoil in the northern area of Glenmere Lake warrants corrective action as the species is invasive and nonnative. According to the NYSDEC's Nuisance & Invasive Species web page, *"Invasive species are non-native species that can cause harm to the environment or to human health. As a threat to our biodiversity, they have been judged second only to habitat loss. Invasives come from all around the world; the rate of invasion is increasing along with the increase in international trade that accompanies globalization. Invasive species have caused many problems in the past, are causing problems now, and pose threats to our future. A wide variety of species are problematic for many sectors of our world: our ecosystems, including all natural systems as well as managed forests; our food supply, including not only agriculture but also harvested wildlife, fish and shellfish; our built environments, including landscaping,*

infrastructure, industry, gardens, and pets. Invasive species have implications, too, for recreation and for human health."

Eurasian milfoil is often a threat to aquatic ecosystems. The plant replaces native vegetation and the organisms that have evolved to live on and around them. The majority of state policies reviewed for this study, from Massachusetts to Washington, indicate an overwhelming support for control of Eurasian water milfoil and eradication where possible.

A number of physical, biological, and chemical methods for controlling aquatic plants have been developed (Cooke et al., 1986 and NYSDEC, 2005). The success and costs of these methods vary widely depending on the plant species involved, the extent of growth of the invasive species, and site-specific factors. Multiple methods are sometimes employed to control persistent species. The following options to control water milfoil are available:

- Hand harvesting
- Suction harvesting
- Benthic barriers
- Water level drawdown
- Mechanical harvesting
- Dredging
- Biological control
- Herbicides

A monitoring-only (i.e., no active control would be undertaken) option may also be considered when the owner of a lake determines that the corrective action can be postponed pending future study. Each of these options is discussed below, with the exception of herbicides. The use of chemical controls was discussed above, including Sonar, and is not recommended for application in Glenmere Lake.

Hand Harvesting – In hand harvesting, scuba divers trained to differentiate the target invasive species from native aquatics remove the invasive plants by hand. The entire plant, including the root crown, is removed and bagged for disposal. Care must be taken to minimize the fragmentation of plants during harvesting. The emplacement of floating barriers similar to oil containment booms around the work area can help reduce the spread of any fragments that might break off. Hand harvesting is the most selective method of control and preserves most native macrophytes. Hand harvesting has been effectively used in both large (Kelting and Laxon, 2010) and small (Bailey and Calhoun, 2008) scale control operations. It is labor intensive, however, and is best suited for removal of relatively small, low density beds of invasive vegetation. Hand harvesting can be inefficient in very dense macrophyte beds. The cost ranges from $400 to $1,000 per acre. Due to its selective nature, hand harvesting may be a prudent solution for control of Eurasian water milfoil in Glenmere Lake.

Suction Harvesting – Suction harvesting involves scuba divers using a barge-mounted suction dredge to remove the invasive plant. In its most effective and selective application, the diver hand pulls the invasive plant, including roots, and feeds it into the suction pipe. The harvested plant material is filtered by a surface unit and disposed. A suction dredge can also be used to simply suck up the plant and associated sediment. However, in this mode of application, the roots may not be completely removed, and there is a greater risk that native plants will be impacted.

Suction harvesting makes more efficient use of the diver's time because the diver does not have to fill bags or deliver them to the surface. The opportunity for release of plant fragments is also considerably reduced with suction harvesting. Disadvantages of suction harvesting include higher cost, a greater potential to remove or damage native plants, disturbance of benthic communities, and creation of a turbidity plume. The cost ranges from $5,000 to 15,000 per acre depending on equipment used, total area and density of plants to be removed, and access/contractor mobilization issues. Due to its relatively selective nature, suction harvesting may be a prudent solution for control of Eurasian water milfoil in Glenmere Lake.

There are many examples of successful harvesting throughout the northeast United States. Several years ago, suction harvesting of one acre of water milfoil was conducted in Crystal Lake in Ellington, Connecticut. A total of 18 bags was removed on the first two days of harvesting, and another 11 bags were removed a week later. A few years later, another round of successful harvesting was conducted. The consultant involved with the milfoil removal determined that only 1% of the milfoil mass remained after the harvesting.

Benthic Barriers – Benthic barriers are sheets of nontransparent material that are installed over the entire invasive plant bed, shading out the plants (Perkins et al., 1980; Bailey and Calhoun, 2008). Plants beneath the barrier typically die within 30-60 days. Various materials have been used, ranging from burlap (not recommended because of short life span) and traditional filter fabric to commercial products (e.g., Aquascreen, Terratrack) specifically designed for this application. Benthic barriers can be installed by divers. Vents have to be cut in nonporous barriers to release gases generated by decomposing vegetation. Barriers need to be periodically maintained to prevent sediment (which could provide rooting substrate for invasive plants) from building up on top of the barrier. The cost ranges from $10,000 to 25,000 per acre for materials and installation, plus the cost of periodic maintenance. Benthic barriers have the disadvantages of being nonselective. They kill both invasive and native plants. They also impact benthic invertebrate communities beneath them and eliminate the use of the covered area for fish spawning (particularly by bass and sunfish). For these reasons, benthic barriers are not appropriate for a lake such as Glenmere where there are many different interests such as recreation, fishing, and provision of habitat to important species.

Water Level Drawdown – Drawdown involves lowering the water level to expose invasive plants and substrate to drying, freezing, and ice scour. The effectiveness of

drawdown is high when winters are harsh but, because of the vagaries of winter conditions, multiple years of drawdown may be required to control the invasive plant species. Water level drawdown is nonselective and will impact all aquatic plant species that are exposed. Drawdown can have a serious impact on the fish community, benthic invertebrates, frogs, and turtles. For Glenmere Lake, drawdown is simply not feasible due to a variety of environmental and practical reasons, including that the lake is the sole source of supply for the Village of Florida water system.

Mechanical Harvesting – Aquatic vegetation can be removed by various mechanical methods such as hydroraking and rotovating. These methods utilize boat- or barge-mounted equipment to cut and remove the invasive plants and are most often used in lakes and reservoirs with serious aquatic weed problems. Mechanical harvesting results in rapid removal of the nuisance plants in areas where they interfere with boating and swimming. Mechanical methods are not particularly effective in removing roots and tend to fragment the plants, which can spread the invasive species to previously unvegetated areas. Rotovating is more effective in removing roots but may leave plant fragments and cause significant benthic disturbance.

Mechanical harvesting is nonselective unless it is performed only in monotypic beds of the invasive species. Mechanical harvesting may also have a serious impact on small fish (particularly sunfish fry) that use the aquatic plants as cover (Mikol, 1984). Annual harvesting (or possibly harvesting multiple times during a season) should be anticipated because of the tendency of these techniques to leave roots and plant fragments from which the plants regrow although the beds may become stressed and less dense with repeated harvesting. The cost ranges from $500 to 1,500 per acre, plus mobilization costs. Due to its nonselective nature, mechanical harvesting is not a prudent solution for control of Eurasian water milfoil in Glenmere Lake.

Dredging – Dredging involves the removal of the invasive plants and associated sediment and disposal of the dredged material in an upland location. Dredging can be performed in the wet, with barge-mounted cutter-head equipment, or in the dry with excavators. Dredging has the advantage of removing the sediment, which acts as a growing substrate and nutrient source for the invasive plant, as well as the plant material itself. Dredging is nonselective unless it is restricted to monotypic beds. Dredging will eliminate the benthic community in the dredged area and may impact fish and other aquatic animals. Dredging has the potential to significantly increase turbidity in the lake. Due to its nonselective nature, its high cost, and its potential to negatively impact plant and wildlife communities, dredging is not a prudent solution for control of Eurasian water milfoil in Glenmere Lake.

Biological Control – Biological control refers to using a predaceous organism to control an invasive species. Two insect species, the milfoil weevil (Euhrychiopsis lecontei) and an aquatic moth (Acentria ephemerella), have been used experimentally and, in a few cases, operationally, to control Eurasian water milfoil. The success of these projects has been highly variable.

The grass carp (Ctenopharyngodon idella), a large (maximum length 125 cm) herbivorous fish native to eastern Asia, has been used to control some species of invasive aquatic vegetation (Mitzner, 1978). Grass carp are inexpensive and are perceived as a "natural" method of control. They are voracious aquatic weed eaters, with smaller fish (<400 mm) able to consume up to 200% of their body weight in vegetation per day. Grass carp have dietary preferences and may consume desirable native plants instead of the target invasive species. Other potential impacts of grass carp introductions include disturbance of sediments, increases in turbidity, and enrichment of the water with nutrients from the fish's fecal matter. Grass carp prefer flowing water and will migrate out of the lake or reservoir unless prevented from doing so by screens or similar structures.

A case study on the Connecticut-New York border suggests that grass carp can be effective in the control of milfoils. In 1997, grass carp were introduced into Ball Pond, an 82 acre lake in western New Fairfield, Connecticut, specifically to control Eurasian water milfoil. Cynthia Stevens, Chairman of the Ball Pond Advisory Committee, stated that the grass carp have nearly eliminated Eurasian water milfoil from the lake although coontail (Ceratophyllum demersum) remains a problem. Ms. Stevens further stated that water quality and fish sampling conducted by the Connecticut Department of Environmental Protection (CTDEP) indicated the grass carp have not impacted water quality or the fish community in the lake.

The use of grass carp would not be allowed by the NYSDEC in Glenmere Lake for a variety of reasons, including the presence of an endangered, threatened, or special concern species (the Northern cricket frog) as well as the size of the lake and its connection to a perennial stream (see http://www.dec.ny.gov/outdoor/7973.html).

Summary – Of the methods described above, only hand and suction harvesting are recommended for Glenmere Lake. These methods should be considered to control the invasive Eurasian water milfoil in the central to northern areas of the lake, with preference given to areas near the water treatment plant intake. Although native water milfoils need not be targeted for removal, the incidental removal of other water milfoils will not likely cause adverse impacts to Glenmere Lake.

Control of Water Lilies

Section 2.7 of this plan describes the presence of water lilies such as yellow water lily and white water lily. Lilies are abundant in the southern parts of Glenmere Lake and less abundant in the northern part of the lake although area residents have indicated that they are increasing in extent. As noted above, a member of the Greenwood Lake Commission noted that aeration has not appeared to harm lilies in Greenwood Lake.

The most appropriate action regarding lilies at the present time is to track their presence and characterize any increases in extent. This will be accomplished through the monitoring described in Section 4.4 below.

4.3 Habitat Protection and Management Strategies

The management techniques discussed throughout Sections 4.1 and 4.2 were evaluated with consideration of the Northern cricket frog. Aside from the specific recommendations promoted for the individual plan elements described herein, no additional best management practices for the protection of the Northern cricket frog have been identified. The species appears to be present in spite of any negative actions that have occurred such as the limited development along the lake and the sometimes heavy water-based recreation. Furthermore, the species is very likely present in part due to the positive actions that have occurred such as the overall protection of the lake and adjacent lands for public water supply. The status quo appears to be largely supportive of the Northern cricket frog population. The additional management practices described in the following sections and their respective recommendations will provide further protections for the Northern cricket frog.

4.4 Monitoring

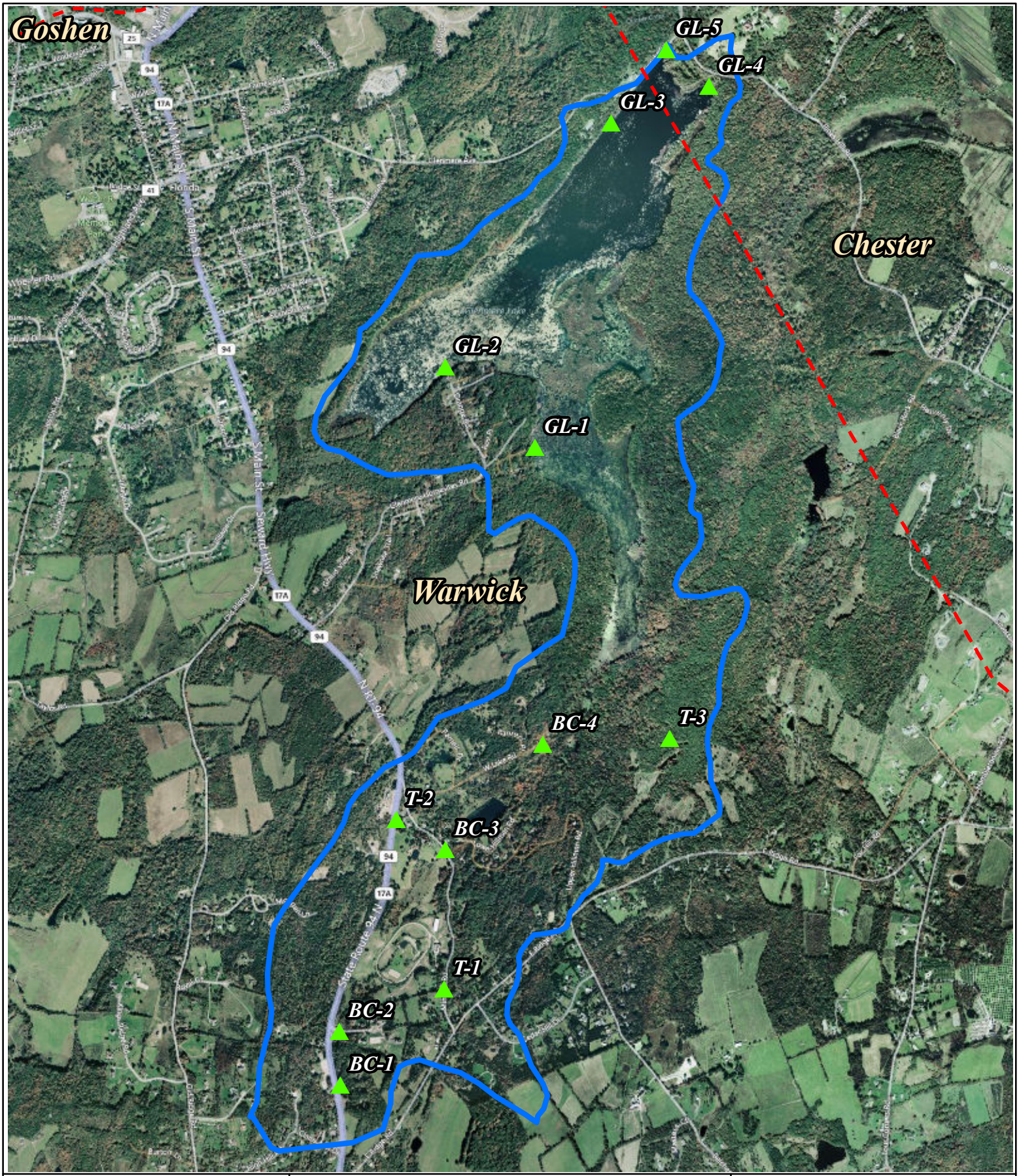
Two types of monitoring programs are recommended for Glenmere Lake: water quality monitoring and aquatic vegetation monitoring. These are described below.

Water Quality Monitoring

Many public water supply watersheds are subject to periodic source water monitoring and testing. Although such testing is not required by the EPA as part of the standard public water supply testing, source water monitoring is helpful for water utilities to understand what actions may be needed to protect water quality and plan for future treatment plant upgrades. The water quality data from a monitoring program, if shared, can also help land use planners guide and regulate development in watersheds. Figure 4-1 depicts potential water quality monitoring locations in the Glenmere Lake watershed. The rationale for each site is provided below:

1. BC-1: Browns Creek at Route 94 near Claire Ann Drive – characterize water quality at the upstream end of the watershed, where only a few residential and commercial properties are upstream of the sample site.

2. BC-2: Browns Creek at Horse Hill Lane – characterize water quality just below the Horse Hill Lake culvert; note that the detention/water quality basin for the Horse Hill Lake development is located on the upstream side of the culvert.



SOURCE:

Basemap:
Bing Maps Hybrid datalayer (c) 2010 Microsoft Corporation and its data suppliers

Drainage Basin Boundary:
Orange County Office of Information Services (5/25/2007)

Figure 4-1: Potential Water Quality Monitoring Locations

LOCATION:
Orange County, NY

N

Glenmere Lake Watershed Assessment and Management Action Plan

Map By: SMG
MMI#: 4515-01
MXD: P:\Pot_WQM_locs.mxd
Date: October 11, 2011
Scale: 1 inch = 2,000 feet

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3. BC-3: Browns Creek at Minturn Road (pictured to the right) – characterize water quality downstream of the horse farm.

4. BC-4: Browns Creek at the end of West Lake Road – characterize water quality downstream of residential areas and Hill Pond; this sample site will be relatively representative of the water flowing into Glenmere Lake.

5. T-1: Tributary of Browns Creek at Minturn Road – characterize water quality of one of the tributary streams; residential areas are upstream.

6. T-2: Tributary of Browns Creek at Route 94 – characterize water quality of one of the tributary streams; Route 94 and commercial properties are upstream.

7. T-3: Tributary of Browns Creek northeast of Upper Hillman Road (if possible due to limited access) – characterize water quality of one of the tributary streams in a forested area.

8. GL-1[9]: Glenmere Lake at the end of Goshen Road – characterize water quality in the southeast arm of the lake and near Glenmere Homesites.

9. GL-2: Glenmere Lake at the end of Orange Road – characterize water quality in the southern part of the lake and near Glenmere Homesites.

10. GL-3: Glenmere Lake at the Village of Florida park – characterize water quality near an area of intense recreational uses.

11. GL-4: Glenmere Lake near Pine Hill Road – characterize water quality downhill from a roadway.

12. GL-5: Glenmere Lake at the dam (pictured to the right) – characterize water quality where the lake flows into Browns Creek.

[9] Samples with a "GL" prefix should not be confused with the temporary sample sites described in Section 4.0.

Water quality monitoring should include a combination of field-measured and laboratory-measured parameters. Field parameters should include temperature, pH, DO, and specific conductivity. Laboratory parameters should include at a minimum the following:

- Nitrate
- Nitrite
- Phosphorus
- Chloride
- Total dissolves solids
- Total suspended solids
- Fecal coliform bacteria

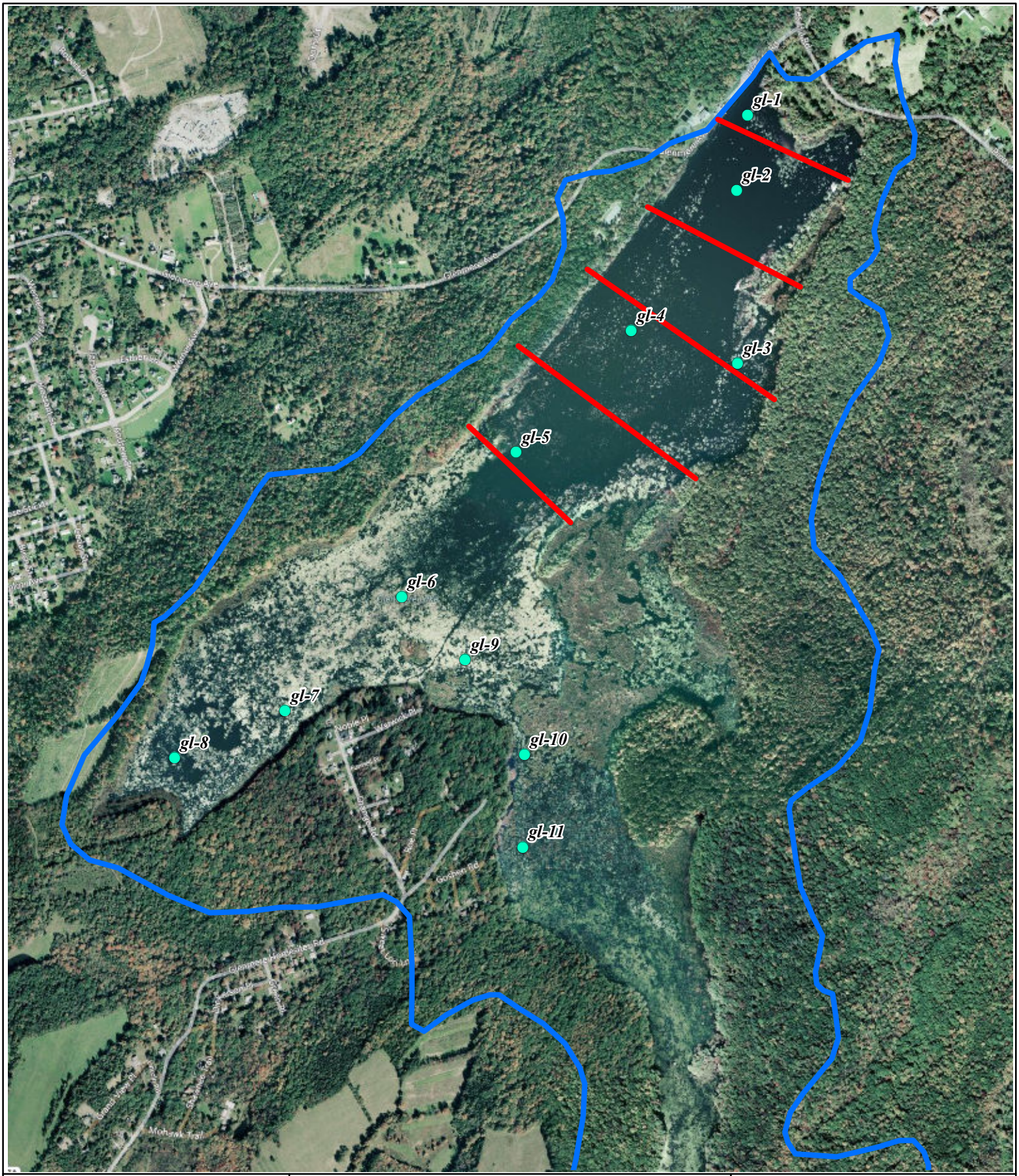
Testing for specific pollutants such as metals, volatile organic compounds, semivolatile organic compounds, pesticides, and herbicides is not recommended unless the Water Authority has reason to believe that a release has occurred. Another option is to include some of these more expensive analyses in a one-time baseline round of sampling, then discontinue such testing after they have been screened.

This plan recognizes that some of the sites in the watershed such as BC-1 may be dry at certain times of the year. Every effort should be made to conduct sampling during runoff events when sites will contain flowing water. In fact, many studies have shown that the heaviest levels of pollutants occur in runoff during rain events and, depending on the time of concentration in the watershed, will be found in streams soon after the rain event. In general, seasonal monitoring is recommended, with dry and wet event sampling scheduled for each spring, summer, and fall. A typical monitoring schedule could include wet- and dry-weather sampling in early April, late July, and mid November.

The monitoring program is recommended to begin in the near future to enable collection of baseline data before additional development occurs in the watershed and/or before any other recommendations of this plan are implemented. It is important to understand that water quality monitoring should not be conducted for the sake of monitoring alone as it can be costly. Monitoring should be viewed as an activity that provides information that can inform land use decisions and help prioritize some of the recommendations of this plan.

Aquatic Vegetation Monitoring

Eurasian water milfoil is considered by many biologists to be aggressive. However, anecdotal evidence from Glenmere Lake has neither supported nor refuted this assumption. A period of aquatic vegetation monitoring is recommended. The water milfoil beds in the lake should be monitored over a period of three to four years to determine if the size and/or density of the beds are changing over time. Findings of the monitoring program would then help inform future harvesting. Figure 4-2 depicts potential transects to be utilized for the vegetation monitoring.



SOURCE:
Basemap:
Bing Maps Hybrid datalayer (c) 2010 Microsoft Corporation and its data suppliers

Drainage Basin Boundary:
Orange County Office of Information Services
(5/25/2007)

Figure 4-2: Potential Vegetation Monitoring Transects

LOCATION:
Orange County, NY

N

Glenmere Lake Watershed Assessment & Management Plan

Map By: SMG
MMI#: 4515-01
MXD: P:\Fig_4-2.mxd
Date: October 11, 2011
Scale: 1 inch = 1,000 feet

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Although milfoil is emphasized, all vegetation along a transect should be quantified and described. This will help characterize the spread, if any, of water lilies.

4.5 Stormwater Management Strategies

As noted in Section 1.3, the role of stormwater runoff and possible sources of erosion relative to water quality in Glenmere Lake is not well documented. New land development proposals in the watershed should include stormwater controls that address both water quantity and water quality. For example, the Horse Hill Lane development includes stormwater controls that appear to include a swale parallel to the roadway and a water quality basin located at the downstream end adjacent to Browns Creek. The basin is not directly connected to Browns Creek.

Numerous existing developed areas are not served by stormwater management systems. Examples of developed areas include the following:

- The Glenmere Homesites neighborhood is not served by an engineered stormwater management system. Stormwater is allowed to run along the sides of the roadways (refer to the picture to the right), crossing under roads in shallow culverts. Erosion is occurring in some locations. Stormwater eventually runs into Glenmere Lake.
- A stormwater pipe was observed discharging directly to the lake at the end of a road in the Glenmere Homesites neighborhood.
- The Hillman Road neighborhood also appears to lack an engineered stormwater system. Stormwater flows along roads and in swales, eventually reaching Browns Creek.

- Intermittent tributaries of Browns Creek cross under Route 94 in at least two locations, and the headwaters section of Browns Creek lies adjacent to Route 94 near Claire Ann Drive. Stormwater systems are minimal or lacking in these areas, and stormwater flows overland into the watercourses.

- A tributary of Browns Creek flows under East Ridge Road and Minturn Road before joining Browns Creek at the horse farm. Where the tributary crosses under and flows along a short section of Minturn Road (pictured to the right), erosion of the stream bank has occurred.

The quality of stormwater runoff can have a direct impact on the quality of surface water supplies. Development oftentimes involves the replacement of vegetated land with impervious surfaces and hence increases the amount of stormwater runoff from a site, decreases infiltration, and alters natural drainage patterns. The increase in impervious coverage both increases the source of pollutants and inhibits the natural pollutant-removal mechanisms offered by vegetated and pervious land.

Some of the greatest threats to drinking water supply reservoirs are the water quality impacts from commercial and industrial land uses, high-density residential areas, construction sites, and high traffic roads and highways. These types of land uses typically contribute the largest sediment loads and pollutants to natural systems. Drinking water quality can be affected by runoff from the most distant reaches of a watershed, not just by development directly adjacent to surface water supply reservoirs. By controlling the sediment and pollutant loading upstream, water quality downstream can be greatly enhanced.

Stormwater Management Methods on Individual Sites

Best Management Practices (BMPs) for stormwater management have improved as new technologies have become available. The Environmental Protection Agency (EPA) classifies BMPs as structural or nonstructural:

- Nonstructural BMPs include good housekeeping, optimizing the use of road sands and salts, semiannual street sweeping, and cleaning of catch basins to remove accumulated sediments.

- The following is a summary of structural BMPs as published in *Preliminary Data Summary of Urban Stormwater Best Management Practices* (EPA, August 1999).

  → Infiltration systems that capture runoff and promote recharge of groundwater.
  → Detention systems that capture runoff and temporarily retain it for subsequent release. Detention systems are typically dry between storm events.
  → Retention systems that capture runoff and retain that volume until it is displaced by the next rain event. These systems maintain a significant pool of water between runoff events.
  → Constructed wetland systems are similar to retention and detention systems except a major portion of the area contains vegetation.
  → Filtration systems typically employ a filter media such as sand, soil, organic material, carbon, or other membrane to remove contaminants from stormwater.
  → Vegetated systems (biofilters) such as swales and filter strips.
  → Vendor-supplied systems that include catch basin inserts, filtration devices, and hydrodynamic devices.

- New development projects should incorporate BMPs to the greatest extent practical. Existing developments can be retrofitted.

Table 4-1 is a summary of preferred BMPs specific to different zoning designations and land uses.

TABLE 4-1
Best Management Practices on Individual Sites

Residential	***Retail/Commercial***	***Both***
Rain gardens or barrels	Pervious parking	Grass swales
Infiltration basins or trenches	Green roof storage	Deep sump catch basins in roads/parking areas
Dry wells	Single sidewalks	Hydrodynamic separators
	Reduction in building footprint	Oil/water separators
	Parking lot storage	Created wetland systems
	Decentralized parking	Bioretention facilities
	Bioretention at parking lot islands	Detention basins

The selection of specific BMPs varies from site to site. Some applications, such as infiltration systems, may not be appropriate for all land uses or all sites. Table 4-2 summarizes the uses and limitations of some common BMPs.

TABLE 4-2
Use and Limitation of Some Common BMPs

BMP Type	*Watershed Size*	*Space Requirements*	*Site Considerations*	*Maintenance*
Rain Barrels	Limited to roof area. Provide multiple barrels to accommodate larger roof areas.	Limited	None	Low
Infiltration Basins or Trenches	Trenches: five acres maximum; two acres recommended. Basins: 25 acres maximum; 10 acres recommended.	Varies with watershed size. Minimum 20 square feet.	Do not use at properties with high potential for sediment load. Keep minimum of 50' from slopes 15% or greater; bottom of unit >3' to water; 75' minimum from wells and septic.	Moderate to high
Dry Wells	< one acre	Varies with watershed size. Minimum 20 square feet.	Not for use where rooftop may contribute pollutants. Bottom of unit 3' above water, 4' above bedrock; 75' minimum from wells and septic.	Low
Pervious Pavement	Traffic volume <500 Average Daily Traffic (ADT).	Not applicable.	Minimum infiltration of underlying soils 0.3 in/hr but less than 5.0 in/hr; no use in aquifer recharge areas except in approved "clean" applications; no use on slopes greater than 15%; depth to water – 3' min., depth to bedrock – 4' min., 75' minimum from wells.	Moderate
Green Roof Storage	Generally limited to roof area.	Varies with size of roof.	Depending on materials used, structural considerations may be needed.	Low
Bioretention/Rain Gardens	5-10 acres; rooftop area for rain gardens.	200 square foot minimum; 25 square foot rain garden.	Slopes 6% or less; 3' from bottom of structure to water.	Low
Grass Swales	As space permits for swale construction.	2' minimum bottom width.	Avoid steep slopes to prevent erosion.	Low
Oil/Water or Hydrodynamic Separators	<1 acre impervious cover.	None. Below grade structure.	None	Low

BMP Type	*Watershed Size*	*Space Requirements*	*Site Considerations*	*Maintenance*
Created Wetlands	25 acre minimum	Proportional to watershed size.	Must intersect ground water if unlined; not appropriate for land uses generating large amounts of contamination; must have base flow into system; steep slopes not appropriate.	Moderate to High
Detention Basins	one acre minimum	Proportional to watershed size.	Must intersect ground water if unlined and wet basin; not appropriate for land uses generating large amounts of contamination; must have base flow into system; steep slopes not appropriate.	Moderate

Stormwater Management Methods for Groups of Developed Sites

New development can involve large-scale projects or take the form of residential subdivisions adjacent to existing developed areas. In these cases, it may be possible to analyze the entire area as a whole and develop stormwater management measures to address the aggregate impervious coverage resulting from the combination of new and existing development. This approach is referred to as centralized BMPs.

In particular, adjacent or clustered commercial and industrial developments can be designed to share storm drainage structures and detention basins to address water quality issues on sites that may otherwise be too restrictive to provide individual management measures. Designs such as this will require cooperation between landowners and developers and may involve permanent easements and/or operation and maintenance programs such as memorandums of understanding (MOU).

Residential subdivisions that share detention or water quality basins could be operated and maintained through a homeowners' association; however, enforcement of proper maintenance is often lacking, and the burden of maintenance often falls onto the municipal entity. MOUs and other agreements can help to prevent this shift of the maintenance burden.

Off-site or centralized treatment can be an effective solution, particularly on more challenging sites or in areas that have previously been developed without BMPs. If possible, systems should be designed to accommodate future potential development in the

area whereby future generators of stormwater would tie in to the system and also enter into agreements for shared maintenance.

In-Line Stormwater Management Methods

Developments in the upper reaches of a watershed that have been constructed without stormwater quantity and quality control measures may contribute sediment and pollutant loading downstream to a reservoir. Because there is no funding source or regulatory requirement to do so, it can be difficult or nearly impossible to retrofit existing development with acceptable stormwater quality measures. Cost, limited land, and land ownership are but a few of the obstacles that must be overcome.

Stormwater from streets can enter watercourses that flow to Glenmere Lake in almost any location where roads cross these watercourses. This is possible via catch basins where curbing is present and by direct flow from the street to the watercourse where curbs are not present. To retrofit these roads would be a sizable undertaking. In order to treat roadway runoff prior to discharge, the water would need to be filtered by either mechanical or natural methods. A retrofit would require costly design and construction of stormwater drainage structures and associated piping. Curbing would be required in locations where the construction of filter swales would be precluded by slope or lack of available land.

One option to address stormwater from existing developments and roadways is to treat the stormwater that has already entered Browns Creek before it discharges into the lake. This method entails the capture of a portion of the silt and sediment load before it reaches the lake through the use of water quality and sediment basins at key locations within the watershed. This type of BMP can mitigate for the cumulative impacts from existing upstream developments.

A regional approach requires the strategic siting of facilities to control stormwater runoff from multiple development projects or large drainage areas. Typically, municipalities, water utilities, and other entities must together assume the capital costs for constructing these facilities as well as the administrative and financial responsibility for their operation and maintenance. The following vital issues should be considered in determining potential locations for such water quality management structures:

- Specific locations for basins should be based on watershed development and stormwater outfall locations.

- The size of the area discharging to the existing stormwater outfall will have an impact on the ability to control peak flows. If a catchment area is too big, then sediments will be flushed from a basin during storm events.

- The direct untreated discharge to the lake from developed areas should be the highest priority for stormwater management.

- The larger the percentage of impervious area within the watershed the more likely it is to increase velocities within contributing streams, thereby increasing sediment transport to downstream reservoirs.

- Areas that are largely disconnected from the storm drainage system typically provide more opportunities for rainfall to infiltrate into the ground. When infiltration is increased, peak flows and erosive water velocities are reduced.

- Land area is a critical consideration for construction of water quality basins. Municipalities or water utilities should either own the land or be able to acquire the land either through purchase or long-term lease agreement. These factors increase the cost and lead time associated with construction.

- Maintenance of stormwater systems is critical to their proper operation. Land on which systems are constructed should be accessible for future maintenance. When maintenance is not performed, the management system ceases to function properly, and water quality is not protected.

Potential Stormwater Management Methods for Glenmere Lake Watershed

Many of the residential and commercial developments in the Glenmere Lake watershed have been constructed with direct discharge of surface runoff to wetlands and watercourses. However, these existing stormwater management systems in the watershed are not necessarily at odds with water quality protection. The conveyance of stormwater in swales and natural stream channels is preferable to the conveyance of stormwater in pipes in situations where retention and detention facilities are not used. However, swales and stream channels should be maintained as vegetated to prevent erosion and subsequent sedimentation of Browns Creek as the creek is the primary feeder to Glenmere Lake.

In the Glenmere Homesites neighborhood, stormwater flows directly from roadways and swales into the lake. This is not consistent with current best practices for water quality protection in New York.

A comprehensive water quality monitoring program for the Glenmere Lake watershed would help determine locations where stormwater management could be most effective. In other words, if the monitoring program identified an area of poor water quality, then upstream areas may be good candidates for new stormwater quality management techniques. Depending on the findings of the water quality monitoring program, the county may wish to assist with stormwater management modifications, retrofits, or installations where none currently exist. The emphasis would be to retain or detain stormwater in basins such as the basin observed at Horse Hill Lake. Potential examples include:

- Installation of limited stormwater system components in the Glenmere Homesites neighborhood to collect stormwater from the roadways and swales and treat the water in a bioretention basin prior to the flow into the lake. This would be an example of centralized facilities/BMPs.

- Elimination of point discharges to the lake such as the one observed in the Glenmere Homesites neighborhood.

- Installation of limited stormwater system components in the Hillman Road neighborhood to collect stormwater from yards, roadways, and swales and treat the water in a bioretention basin prior to the flow into Browns Creek. This would be another example of centralized facilities/BMPs.

- Installation of an in-line water quality basin upstream of Minturn Road for addressing water quality impacts from runoff in the headwaters portion of the watershed.

- Coordination with Cornell Cooperative Extension and/or other agencies to stabilize watercourses where erosion has been observed, such as the tributary associated with Minturn Road.

- Coordination with Cornell Cooperative Extension and/or other agencies to evaluate runoff patterns on the horse farm, with the goal of ensuring that stormwater has an adequate opportunity to be filtered prior to its discharge to Browns Creek.

As mentioned above, these potential stormwater management modifications should be linked to the findings of a water quality monitoring program. It would be unwise to spend local and county resources to correct a problem that may not be impairing water quality.

4.6 Land Management Strategies

Recreation

Section 2.3 provides an overview of recreational uses of Glenmere Lake. Although many water supply reservoirs are closed to the public, Glenmere Lake provides a variety of recreational opportunities. The Village of Florida's Park at Glenmere Lake is located on the western shoreline just south of the treatment facility and is used for picnicking and passive recreation. A boat launch is available in the park. Recreational activities in the lake include kayaking and canoeing, and usage can be heavy at times. Swimming is not permitted.

Fishing from the shore and from canoes is common. Smallmouth bass and pickerel are reported by area residents to be the most popular fisheries. Other fish present may include Black crappie, Yellow perch, and Grass pickerel.

Local residents report that the lake has historically been an excellent fishery resource but that the proliferation of aquatic vegetation has hindered fishing in recent years. Water milfoil can complicate fishing and is located mainly in the part of the lake that is nearest the village's park and boat launch. This is also the part of the lake with the deepest water column of appropriate DO for fisheries. Therefore, control of Eurasian water milfoil through hand and/or suction harvesting may help improve the fishing experience at Glenmere Lake.

Only the upper layers of water in the southern and southeastern parts of the lake have sufficient DO for fish. These areas are most distant from the village's park, and it is not recommended that aquatic vegetation be reduced here for improved fishing.

Canoe instructors (Mr. David Sinish of Collinsville Canoe and Kayak, personal communication) report that depths of less than eight feet will cause drag that may be imperceptible to people in canoes and kayaks but nevertheless impedes movement. Aquatic vegetation will likewise cause drag. Fortunately, the deepest parts of Glenmere Lake are near the park, such that launching and use of canoes and kayaks will be easiest for the majority of the people who use the lake for such purposes. Those people who venture into the southern and southeastern parts of the lake will experience drag due to aquatic vegetation. However, these areas are naturally shallower and can be used by more experienced boaters that desire such conditions.

Large tracts of land adjacent to Glenmere Lake are not available for public access. This plan does not propose that these areas be formally opened to the public. As a public water supply, the watershed lands should be prioritized for protection of water quality.

In order to further prevent introduction of non-native species into Glenmere Lake through recreational uses that allow contact with the lake water, precautions should be taken in the locations of significant public access. For example, boat and boot/wader cleaning stations could be located in the vicinity of Glenmere Homesites and in the Village’s park.

Future Development

As noted in Section 1.3, a number of development projects have been proposed and/or constructed in recent past. The Glenmere Preserve Planned Adult Community is the most notable of the currently pending projects in the watershed. The most recent version of the application for the project is dated 2010, and "Alternative 1B" is reportedly the favored layout from the county's perspective. This layout minimizes development in the Glenmere Lake watershed by constraining it to the portions of the property located just beyond the watershed line. All of the property associated with the Glenmere Preserve is located in land annexed by the Village of Florida.

The developer of the Glenmere Preserve project submitted proposed zoning regulation amendments in mid 2011. Many of the proposed changes were geared toward allowing minor changes in the number of units allowed, but none appeared to affect land in the

watershed. Given this recent action relative to the property, it appears that the developer remains interested in pursuing the Glenmere Preserve project. The Water Authority and the county should continue to provide technical review services for any revisions to the application given the close proximity of Glenmere Lake. The maximum possible distance between Glenmere Lake and the housing units and their appurtenant structures (parking, driveways, stormwater systems, etc.) should be sought, and state-of-the-art design considerations should be employed for water quantity and water quality protection as well as Northern cricket frog habitat preservation.

Few additional developments, if any, are currently proposed in the watershed. According to the Water Authority, a proposed development known as "Mountain View Estates" was first presented to the county in 2007. The development would have approximately 50 units. Very little action has occurred since 2007, and an application was never submitted.

Aside from the occasional isolated development of single lots, development pressures in the watershed are scarce at the present time. However, it is recognized that economic conditions can change. The existing zoning of the three municipalities in the Glenmere Lake watershed is adequate for maintaining low development densities, which can help minimize adverse impacts to water quality when all other things are equal such as the sizes of dwelling units and areas needed for driveways and the like.

The Town of Warwick Comprehensive Plan discussed the idea of developing and adopting a "Public Water Supply Watershed Overlay District." The district would provide for additional protections relative to stormwater runoff, nutrients, and septic system wastes, and Glenmere Lake was suggested as one of the watersheds to include as an overlay district. Because the developable part of the Glenmere Lake watershed is comprised mainly of the town of Warwick, a Public Water Supply Watershed Overlay District could provide increased protections to water quality in Glenmere Lake above and beyond the minimal protections afforded by low density zoning.

Acquisition of land for open space is often the best means of protecting water quality in a public water supply watershed. The Town of Warwick CPPP lists a number of parcels associated with Glenmere Lake. Selective pursuit of some of these parcels may be advantageous for helping to protect water quality in Glenmere Lake as future development would be precluded from these properties.

5.0 SUMMARY OF FINDINGS AND RECOMMENDATIONS

5.1 Findings

General

1. Glenmere Lake and its 2.5 square mile contributing watershed encompass portions of the towns of Warwick and Chester in addition to portions of the village of Florida within Orange County. The lake serves multiple functions and needs. It is the sole source of public water supply to the village of Florida. The lake and adjacent land areas serve as a recreational resource to area residents on and near the lake for nonmotorized boating, fishing, bird hunting, walking, picnicking, and various forms of passive recreation. It provides habitat for a variety of plant and animal species, including the endangered Northern cricket frog (*Acris crepitans*), and it serves as an aesthetic amenity to residents and visitors alike.

2. A variety of investigations and studies have been conducted within and around Glenmere Lake by different entities and for different purposes. The subject Watershed Management Plan provides an inventory of related work and provides a summary of their content.

Water Supply

3. Glenmere Lake is the sole source of public water supply for the village of Florida. The average daily demand in the year 2010 was 473,044 gpd. Customers include 2,820 residents in the village of Florida who are served via 1,008 service connections and several customers outside the village in the town of Goshen including the Orange County Correctional Facility, Valley View Nursing Home, Hearthstone Apartments, the Department of Social Services facility, and Emergency Services facility.

4. Legal rights to the top 15 inches of water were established by a water company in 1899. When the Village of Florida purchased the private water company in 1987, it acquired the rights to the lake water, water system facilities (including the filtration plant), and distribution system components.

5. Several analyses of safe yield have been conducted to determine the capacity of Glenmere Lake to reliably provide water (quantity) to the supply system. A 1967 analysis described the dependable yield of Glenmere Lake to be 0.6 mgd whereas a safe yield analysis prepared in April 1993 (supported by a bathymetric survey) described a safe yield of 0.5 mgd and a total storage volume of almost 500 million gallons at a water surface elevation of 533 feet.

6. The State of New York Department of Health completed a Source Water Assessment Report for Glenmere Lake in 2005. The assessment found a "moderate

susceptibility to contamination for this source of drinking water. The amount of pasture in the assessment area results in a medium potential for protozoa contamination. No permitted discharges are found in the assessment area. There are no noteworthy contamination threats associated with other discrete contaminant sources. Additional sources of potential contamination include septics."

7. The Village of Florida monitors disinfection byproducts as required by Stage 1 of the EPA's Disinfection Byproducts Rule. In 2010, TTHM levels ranged from 36.6 ug/L to 112.4 ug/L, and HAA5 levels ranged from 22.1 ug/L to 81.6 ug/L depending on month and sample location in the system. Similar ranges were detected in the year 2009. The MCLs for TTHM and HAA5 are 80 ug/L and 60 ug/L, respectively. Violations did not occur as a result of the higher measurements since Stage 1 of the Disinfection Byproducts Rule requires that averages be compared to the MCLs, rather than a single measurement. Nevertheless, the occasional elevated levels of TTHM and HAA5 indicate that TOC is relatively high in Glenmere Lake and that water age is likely excessive in the extremities of the distribution system.

Aquatic Vegetation

8. The wetland communities within the lake include palustrine open water, palustrine emergent, and palustrine scrub shrub. Palustrine forested wetlands are located along the periphery of Glenmere Lake. These wetland communities demonstrate an ongoing transition from open water to palustrine forested wetland, with some large areas in the southern part of the lake already characterized by wide regions of scrub/shrub.

9. Submerged and floating aquatic vegetation have been present in Glenmere Lake since at least the beginning of the 20th century. Emergent aquatic vegetation has been reported since at least the 1970s or earlier. Specific types of aquatic vegetation have been described since the early 1990s. Over the lifetime of the lake and based on a compilation of both anecdotal and scientific reports, the areal extent of aquatic vegetation has increased. The vast majority of these species are native. A comprehensive aquatic vegetation monitoring program is not currently in place for the lake.

10. Invasive Eurasian water milfoil is present in the north-central and northern portions of Glenmere Lake although it was not among the most common submerged aquatic plant species present in the Lake.

Habitat

11. Glenmere Lake provides habitat for a variety of plant and animal species, including the endangered Northern cricket frog (*Acris crepitans)*. The Northern cricket frog is a small species of tree frog that prefers the margins of slow moving waterbodies including lakes, ponds, and rivers and then hibernates in adjacent upland areas. The

presence of Northern cricket frog communities in and around Glenmere Lake has been documented in a number of studies. NYSDEC considers the population surrounding Glenmere Lake to be the largest population in New York State.

12. The Wallkill River Watershed Conservation and Management Plan, of which Glenmere Lake is a part , emphasizes preservation of high quality habitat, protection of species of concern, and provision of public access. The subject Glenmere Lake Watershed Management Plan is aligned with the Wallkill River Watershed Conservation and Management Plan.

Water Quality

13. Comprehensive water quality assessment has not been conducted for Glenmere Lake, and very little site-specific data exists. MMI conducted limited water quality assessment as part of this Watershed Management Plan.

14. DO levels measured in Glenmere Lake in June and August 2011 are generally appropriate to support fish communities, with the exception of the southern and southeastern arms of the lake and the deeper zones in the central-north parts of the lake, where conditions range from low DO to nearly anoxic.

15. Temperatures measured in the lake in June 2011 show a weak stratification whereas temperatures measured two months later do not. In general, Glenmere Lake is likely too shallow to develop strong and persistent stratification.

16. Water depths measured at 11 locations in June and August 2011 were compared to the bathymetric map that was completed as part of the safe yield study in 1993. In general, the bathymetry documented in 1993 appears to be the same as the bathymetry observed in 2011. The similarity in water depths from 1993 to 2011 indicates that sedimentation and filling of Glenmere Lake has not been significant in the past two decades. This is consistent with the small watershed and the lack of piped surface water discharge from large impervious areas into the lake.

17. The Orange County Water Authority has been conducting stream biomonitoring since 2004. Published results indicate a BAP score of 7.8 for Browns Creek at West Lake Road (upstream of the reservoir) for the September 2004 assessment. The score of 7.8 represents a nonimpacted stream with very good water quality and a diverse macroinvertebrate community. The ISD scores for this site indicate a benthic community structure most similar to one affected by municipal/industrial inputs, but the finding was reportedly spurious as the subsample included species that are indicators of good water quality.

18. Over the years, there have been reports from residents that high ground water and failing septic systems in the Glenmere Homesites neighborhood may be contributing to the release of septic system-related nutrients to Glenmere Lake. Likewise, the

Source Water Assessment Report for Glenmere Lake states that there are homes with septic systems in proximity to the reservoir.

19. A comprehensive water quality monitoring program is not currently in place for the Glenmere Lake watershed.

Hydrology and Stormwater Management

20. The estimated 7Q10 (lowest predicted flow occurring over seven days every 10 years) and 7Q2 (lowest predicted flow occurring over seven days every two years) for Browns Creek at the Glenmere Lake inlet (watershed area of 0.98 square mile) are 0.007 cfs and 0.029 cfs, respectively. These are equivalent to approximately 4,500 gpd and 18,700 gpd, respectively. In contrast, the estimated 100-year statistical frequency discharge at the same location is 277 cfs.

21. Stormwater generated in the watershed appears to be relatively unmanaged. More recent developments such as the homes along Horse Hill Lane have been developed with water quality controls, but older developments such as the Glenmere Homesites or the neighborhood around Hill Pond are without stormwater controls. Minor areas of erosion were observed throughout the watershed, mainly along roadways where runoff is concentrated.

22. Temperature measurements of water in Glenmere Lake support statements from residents that ground water may contribute to lake hydrology. However, data is lacking to draw a conclusion relative to the significance of ground water in the overall lake water budget.

Land Management

23. The watershed supports a variety of residential, commercial, and open space land uses. Zoning in the watershed largely supports large-lot (low density) development, which is often used across the United States as the default for protection of public water supplies.

24. The Village of Florida adopted Watershed Rules and Regulations for the Glenmere Lake watershed in 1925. The Watershed Rules and Regulations have not been updated since then. The NYS Department of Health provides a form entitled "Annual Report on Violations of Watershed Rules and Regulations" on its website that is available to water utilities that have adopted rules and regulations. The form can be used to help guide watershed inspections.

25. Recent development pressures have been relatively few in number in the watershed as well as in the area surrounding the watershed. One significant development is currently pending various approvals (the Glenmere Preserve housing development). This development is largely outside the boundaries of the Glenmere Lake watershed.

26. The Village of Florida Comprehensive Plan notes that watershed rules and regulations can protect Glenmere Lake from future development and some pollutants, but they cannot protect it from some existing conditions. Additionally, the plan notes that roads allow for oils to enter the watershed system. The plan also notes that as future development occurs along with new EPA stormwater regulations, "it is hoped that these regulations will assist in reservoir protection."

27. The Town of Warwick Comprehensive Plan recommends development and adoption of a Public Water Supply Watershed Overlay District. The district would provide for additional protections relative to stormwater runoff, nutrients, and septic system wastes. Glenmere Lake was suggested as one of the watersheds to include as an overlay district.

28. The Town of Warwick CPPP lists a number of parcels associated with Glenmere Lake. The listing of these parcels in the CPPP implies that there has been an interest in acquiring some of them for open space.

29. An approximately 9.9-acre brownfield site is located at the north end of Glenmere Lake. The site is owned by Orange County and includes the remnants of several buildings and a variety of debris. Contaminants of concern on this site include lead and arsenic in the soil and sediment downgradient in Glenmere Lake and petroleum in the sediments surrounding former tanks located on site. The remedy selected by the NYSDEC includes demolition and disposal of buildings, disposal of solid waste present at the site, excavation and disposal of contaminated soils that exceed soil cleanup criteria for lead and arsenic, and removal of contaminated sediments in Glenmere Lake within 40 feet of shore. Cleanup of this site is expected to reduce the potential for related contaminants to impact the public water supply.

5.2 Recommendations

A summary of management strategies from this plan is provided in Appendix D. The summary links the various management strategies to the recommendations listed in this section.

General

1. Modifications to Glenmere Lake's allowed recreational uses are not recommended. The lake is already providing a broad range of recreational uses beyond those allowed in many public water supply reservoirs. However, individuals who launch kayaks, canoes, and other watercraft into the lake must take precautions to ensure that nonnative species will not be introduced to Glenmere Lake.

Water Supply

2. Glenmere Lake is the sole source of public water supply for the village of Florida and customers in Goshen and lacks source redundancy. Evaluation of an alternate or emergency backup supply is recommended to reduce vulnerability. An interconnection with another water utility such as the Goshen public water system could provide backup supply to the Florida system in the event that Glenmere Lake were to become compromised due to quantity or quality concerns. Alternatively, the village could augment its supply by adding wells either through strategic purchase of existing wells or by developing new wells.

3. Several analyses of safe yield have been conducted for Glenmere Lake, and these appear to be reasonable for the watershed. However, an updated calculation of safe yield is recommended to account for bathymetric conditions with a reasonable reduction for the volume of water displaced by aquatic vegetation; stream inflows based on stream flow measurements, a nearby gauging station, or the most recent regression equations developed for the region; reasonable releases to Browns Creek downstream of the dam; and a limit on lake level drawdown. Subsequent to the safe yield analysis, projected margins of safety should be estimated to ensure that the safe yield can accommodate future growth in the Village.

4. Depending on the results of the revised safe yield analysis, Glenmere Lake could be managed to provide reasonable releases to Browns Creek downstream of the dam. The potential range of releases should be evaluated in concert with the safe yield analysis. This plan recognizes that modifications to the dam are likely required to manage releases to Browns Creek.

5. The Village of Florida should be planning for compliance with Stage 2 of the EPA's Disinfection Byproducts Rule. As such, the village should focus on reducing TOC in the water near the intake and reducing water age in the extremities of the distribution system. If these two efforts are not sufficient to reduce TTHM and HAA5 levels below their respective MCLs as determined through locational averages, then additional treatment processes would need to be evaluated.

6. The Village of Florida should conduct annual watershed inspections to identify problem conditions or practices so that they may be corrected. Local assistance may be sought in this effort. The state's watershed inspection form is included in Appendix C.

7. The Village of Florida should consider updating its Watershed Rules and Regulations to address current potential threats to the public water supply. This would be consistent with the Source Water Assessment Report.

Aquatic Vegetation

8. A comprehensive aquatic vegetation monitoring program is recommended to document shifts in aquatic vegetation species and density. The monitoring would include both invasive and noninvasive species and would provide information that could be used to plan future milfoil management as well as help address future questions about the speed of native aquatic plants spreading in the lake.

9. Eurasian water milfoil is invasive and should be removed from the lake using hand or suction harvesting techniques regardless of the speed of its proliferation in Glenmere Lake. Its removal is considered the most responsible action to help restore a more natural ecological balance for Glenmere Lake. Although success rates can be high using these methods, this plan recognizes that repetitive harvesting will likely be necessary.

10. If aeration is pursued by the Village of Florida for control of algae in Glenmere Lake, then it should be constrained to the northern portions of the lake nearest the water treatment plant intake and should be verified by an independent limnologist as cost effective.

11. Application of fluridone (Sonar) is not recommended for Glenmere Lake as it is a public water supply. This plan neither supports nor rejects the continued use of copper sulfate. The Village of Florida is advised to follow the conditions of its copper sulfate use approvals and is encouraged to reduce the frequency and concentrations of the applications to the extent possible.

12. Given the low rate at which sediment is accumulating in the lake, dredging is not recommended. The potential negative impacts of dredging – including but not limited to habitat disturbance, increased turbidity, temporarily reduced recreational value – combined with the high costs of dredging render this alternative imprudent.

13. Given the continued interest by residents for thinning some of the aquatic vegetation along the Glenmere Homesites lakeshore, this plan supports the pursuit of approvals from NYSDEC to judiciously remove vegetation for enhanced recreational access. Such removal would be confined to a limited area near Glenmere Homesites, and methods would include only the harvesting techniques supported by this plan.

Habitat

14. Glenmere Lake's role as habitat for a variety of plant and animal species, including the endangered Northern cricket frog, should not be weakened. Land use management within the contributing watershed to the lake and water quality management in the lake should be reviewed and assessed to maximize water quality and habitat protection for preserving the Northern cricket frog populations. This is consistent with desired water quality protection relative to drinking water supply.

15. Hand harvesting or suction harvesting of water milfoil instead of the use of fluridone, mechanical harvesting, benthic barriers, drawdown, dredging, and biological controls is believed to be most protective of the Northern cricket frog. Aeration appears to be neither beneficial nor detrimental to the frog given its planned restriction to the northern portion of Glenmere Lake and the likely lack of adverse impacts to the dense aquatic vegetation found elsewhere in the lake.

Water Quality

16. A comprehensive water quality monitoring program for the Glenmere Lake watershed is recommended to understand what actions may be needed to protect water quality and plan for future treatment plant upgrades and help land use planners guide and regulate development and stormwater management. A list and map of suggested sampling/monitoring locations is presented in Section 4. This work could potentially have a low cost if volunteers were utilized.

17. Depending on the findings of the water quality monitoring program, watershed municipalities, possibly in concert with the county, may wish to assist with stormwater management retrofits or installations where none currently exist. Examples are provided in Section 4.5 of this plan.

18. New land development proposals in the watershed should include stormwater controls that address water quantity and water quality. While NYSDEC stormwater regulations pertain to certain types and levels of development, the watershed municipalities should strive to go above and beyond what is already required.

19. Because there is limited information to verify the reports of possible septic system-related nutrient contributions to Glenmere Lake, the county should partner with the Village of Florida and/or the Town of Warwick to conduct a sanitary evaluation of the Glenmere Homesites neighborhood to document the condition of septic systems and the potential for releases to the watershed. Any repairs to septic systems would be the responsibility of individual property owners.

Land Management

20. Stakeholders should continue to be actively involved with the Glenmere Preserve housing development application process to ensure that the maximum possible distance between Glenmere Lake and the housing units is achieved and that state-of-the-art design considerations are employed for water quantity and water quality protection as well as Northern cricket frog habitat preservation.

21. The Town of Warwick should proceed with its plans to adopt a Public Water Supply Watershed Overlay District for Glenmere Lake.

22. The Town of Warwick should proceed with implementation of its CPPP and prioritize those listed parcels that are associated with Glenmere Lake.

23. The remedial action at the adjacent county-owned brownfield site is consistent with desired watershed and lake management measures and should proceed as planned.

5.3 Plan Implementation

Table 5-1 lists the above recommendations, with minor reorganization such that common recommendations have been combined. Potential costs are provided qualitatively as "low," "medium," or "high" with the following assumptions:

- "Low" costs have either no cost or they can be handled by existing municipal, county, or state personnel with few outside expenses.
- "Medium" costs would require less than $100,000 to implement and may include studies or investigations.
- "High" costs would require a greater level of funding with identified sources of the funding and may include capital expenditures for land acquisition or major projects involving construction or infrastructure.

The entries in the timetable column are similarly divided into three categories:

- "Ongoing" indicates recommendations that are underway and should continue.
- "Near-Term" indicates recommendations that should be implemented in the next two years, some of which may continue for a period of time or indefinitely.
- "Long-Term" indicates recommendations that should be pursued within 10 years, some of which may continue for a period of time or indefinitely.

For some of the recommendations, it may be feasible and prudent to organize a volunteer group to conduct some of the tasks. A good example is the recommendation to conduct watershed inspections. A group comprised of residents and other watershed stakeholders would have the on-the-ground knowledge that is appropriate for this kind of task. For other recommendations, it may not be appropriate for a group of volunteers to conduct the associated tasks, but volunteers may be appropriate for overseeing or advising the associated tasks. For example, the removal of invasive milfoil must be conducted by trained personnel who are experienced in such matters but may be overseen by a group of stakeholders with interest in the project.

Where "Orange County" is listed as a potentially responsible entity for a specific recommendation, this may include any county department or the Water Authority. The use of "volunteers" for some implementation projects could substantially decrease the project costs. "All watershed stakeholders" refers to the municipalities, Orange County, Glenmere Conservation Coalition, homeowners, and all parties that are interested in watershed management of Glenmere Lake.

TABLE 5-1
Implementation of Recommendations

Recommendation	Cost	Timetable	Responsible Entity
Individuals who launch watercraft into the lake must take precautions to ensure that nonnative species will not be introduced.	Low	Ongoing	Village of Florida and Orange County
Evaluate and pursue an alternate or emergency backup supply such as an interconnection with another water utility or inclusion of wells.	High	Near Term	Village of Florida and Orange County
Conduct an updated calculation of safe yield to account for bathymetric conditions with a reasonable reduction for the volume of water displaced by aquatic vegetation, stream inflows, reasonable downstream releases to Browns Creek, and a limit on lake level drawdown.	Medium	Near Term	Village of Florida and Orange County
Evaluate a potential range of releases to Browns Creek from the dam in connection with the safe yield analysis.	Medium[1]	Long Term	To be determined
Focus on reducing TOC in the water near the intake and reducing water age in the extremities of the distribution system.	High	Near Term	Village of Florida and Orange County
Update the village's Watershed Rules and Regulations.	Low	Near Term	Village of Florida and Orange County
Conduct annual watershed inspections to identify problem conditions or practices so that they may be corrected.	Medium	Near Term	All the watershed municipalities and Orange County; volunteers
Implement a comprehensive aquatic vegetation monitoring program to document shifts in native and nonnative aquatic vegetation species and density.	Medium	Near Term	Village of Florida and Orange County; volunteers
Remove invasive Eurasian water milfoil from the lake. Utilize hand harvesting or suction harvesting of water milfoil.	High	Near Term	Village of Florida and Orange County; volunteers
Retain an independent limnologist to determine if aeration is cost effective and constrain aeration to the northern portions of the lake nearest the water treatment plant intake.	Medium	Near Term	Village of Florida
Attempt to reduce the frequency and concentrations of the copper sulfate applications to the extent possible.	Low	Near Term	Village of Florida
Avoid dredging of Glenmere Lake.	Low	Ongoing	Village of Florida and Orange County

Recommendation	Cost	Timetable	Responsible Entity
Work with NYSDEC to gain approvals and permits for judiciously thinning or removing some of the aquatic vegetation near the Glenmere Homesites lakeshore in order to increase recreational access.	Medium	Long Term	Town of Warwick and Orange County
Continue to review and assess land use management within the contributing watershed to the lake and water quality management in the lake to maximize water quality and habitat protection for preserving the Northern cricket frog populations.	Low	Ongoing	All the watershed municipalities and Orange County
Implement a comprehensive water quality monitoring program for the Glenmere Lake watershed. Consider Citizens Statewide Lake Assessment Program (CSLAP) volunteer program through NYS Federation of Lake Associations.	Medium	Near Term	Village of Florida and Orange County; volunteers
Depending on the findings of the water quality monitoring program, pursue stormwater management retrofits or installations in the watershed where none currently exist.	High	Long Term	All the watershed municipalities and Orange County
Ensure that new land development proposals in the watershed include stormwater controls that address water quantity and water quality.	Low	Ongoing	All the watershed municipalities and Orange County
Conduct a sanitary evaluation of the Glenmere Homesites neighborhood to document the condition of septic systems and the potential for releases to the watershed.	Medium[2]	Near Term	Town of Warwick, Village of Florida, and Orange County
Continue to be active in the Glenmere Preserve housing development application process to ensure that the maximum possible distance between Glenmere Lake and the housing units is achieved and that state-of-the-art design considerations are employed for water quantity and water quality protection as well as Northern cricket frog habitat preservation.	Low	Ongoing	All watershed stakeholders
Adopt a Public Water Supply Watershed Overlay District in the town of Warwick.	Low	Near Term	Town of Warwick
Implement portions of the Warwick CPPP and prioritize those listed parcels that are associated with Glenmere Lake.	High	Long Term	Town of Warwick
Proceed with the remedial action at the adjacent brownfield site.	High	Near Term	NYSDEC and Orange County

1. Modification of the dam for making managed releases would have a high cost.
2. Costs of the repairs of septic systems would be borne by property owners.

Through consultation with the advisory committee, seven recommendations have been further identified as the highest priority for implementation following publication of this plan. These are:

1. Update the village's Watershed Rules and Regulations – The Watershed Rules and Regulations can be updated by the Village of Florida working with the watershed municipalities, the County, and the NYS Department of Health. The NYS Department of Health should be contacted to commence the process.

2. Take precautions to prevent introduction of non-native species into Glenmere Lake – Potential cleaning stations could be located in the vicinity of Glenmere Homesites and in the Village's park.

3. Implement a comprehensive aquatic vegetation monitoring program to document shifts in native and nonnative aquatic vegetation species and density – The monitoring program should be implemented by the Village of Florida and the County through a contract with a non-conflicted entity that has significant expertise identifying aquatic species. Over time, volunteers may be able to assist the Village and the County in vegetation monitoring after a set of protocols has been established.

4. Conduct an updated calculation of safe yield – The updated calculation should account for bathymetric conditions with a reasonable reduction for the volume of water displaced by aquatic vegetation, stream inflows, reasonable downstream releases to Browns Creek, and a limit on lake level drawdown. The study should be completed by an engineering firm with sufficient expertise in both water supply and balancing environmental issues such as maintenance of instream flows.

5. Conduct a sanitary evaluation of the Glenmere Homesites neighborhood – The sanitary survey should document the condition of septic systems and the potential for releases to the watershed. The Town of Warwick, Village of Florida, and Orange County may be able to jointly conduct this type of evaluation.

6. Further evaluate aeration to determine its cost effectiveness for enhancing water quality – This evaluation should be conducted by a non-conflicted reputable entity that has significant expertise in evaluating aeration system. Close coordination with NYSDEC will be required. During the December 7, 2011 public meeting, NYSDEC personnel recommended that a pre-application meeting be scheduled at the appropriate date to discuss aeration.

7. Evaluate and pursue an alternate or emergency backup supply – Given the long lead time necessary to secure a redundant water supply for the Village of Florida, the evaluation phase was deemed by the advisory committee to be a high priority. A backup supply could consist of an interconnection with another water utility or development of water supply wells within or in proximity to the Village. This plan recognizes that this priority recommendation is much more costly than the other six.

Table 5-1 should be reviewed and revised as needed but not less than once per year. The Orange County Water Authority should oversee any updates to the table.

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Appendix A
Source Water Assessment Report

STATE OF NEW YORK
DEPARTMENT OF HEALTH

Flanigan Square, 547 River Street, Troy, New York 12180-2216

Antonia C. Novello, M.D., M.P.H., Dr.P.H.
Commissioner

Dennis P. Whalen
Executive Deputy Commissioner

April 5, 2005

NY3503527
FLORIDA VILLAGE
Florida Mayor and Village Board
VILLAGE OF FLORIDA
33 SOUTH MAIN ST., POB 505
FLORIDA
NY 10921

Re: Source Water Assessment (SWAP) Report

Dear Florida Mayor & Village Board:

A copy of the source water assessment report for your source(s) is enclosed.

Each assessment report includes the following elements

Report: This includes narrative text, results tables, a summary table, and a summary of the contents of the SWAP SDWIS add-on database for your source(s).
Map: This map illustrates the location of your intake(s), the land area draining to your source(s), and potential contaminant sources.
CI List: A list of potential contaminant sources within the delineated assessment area for your source that do not have permitted discharges.
PD list: A list of potential contaminant sources within the delineated assessment area for your source that has permitted discharges.

This report contains an Executive Summary in the narrative text that was used as the basis for creating a SWAP summary for your Annual Water Quality Report (AWQR). A SWAP summary must be included in your AWQR. As a reminder, by May 31, 2005, your AWQR should be distributed to your customers, and must be submitted to the NYS DOH and the Orange County Department of Health. Guidance to assist you in writing your 2005 AWQR is available on our website: http://www.health.state.ny.us/nysdoh/water/annual_water_quality_report.htm.

Please be advised that you are not required to share information from the SWAP report, beyond the summary enclosed in your AQWR, with the general public. However, please feel free to share portions of this report that you do not think pose a security threat to your water supply.

If you have any questions regarding your SWAP report, please contact Mr. Jim Hyde of the NYS DOH at (518) 402-7711 or jbh01@health.state.ny.us.

Sincerely,

Lloyd Wilson, Ph.D.
Section Chief
Source Protection Section

Enclosures

cc: Mr. D. Kirkcaldy - Orange Co. Health Dept.

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1.0 Executive Summary

This assessment found a moderate susceptibility to contamination for this source of drinking water. The amount of pasture in the assessment area results in a medium potential for protozoa contamination. No permitted discharges are found in the assessment area. There are no noteworthy contamination threats associated with other discrete contaminant sources. Additional sources of potential contamination include: septics.

2.0 Introduction

This report was completed under the NYS DOH's Source Water Assessment Program (SWAP). The purpose of this program is to compile, organize, and evaluate information regarding possible and actual threats to the quality of public water supply (PWS) sources. The information contained in assessment reports will assist the State in overseeing public water systems and help local authorities in protecting their source water quality. It is important to note that source water assessment reports estimate the potential for untreated drinking water sources to be impacted by contamination. These reports do not address the safety or quality of treated finished potable tap water.

The source water assessment reports are based on reasonably available information, primarily from statewide databases. Although efforts have been made to check each source water assessment report for accuracy, the large scope of this program and the nature of the available data makes the elimination of all errors from these reports nearly impossible.

The following steps were performed for each assessment:

1. Delineation of the source water assessment area(s) – Assessment area borders are created using topography (high points and ridgelines) to define the land area that drains water to each drinking water source. In most cases the assessment area contains only one zone. However, second zones were created where upstream impoundments and/or large geographic distances impede the movement of contaminants toward the PWS source.

Along with creating assessment area borders, all PWS sources are assigned a waterbody type category (e.g. river, spring, large lake, etc) and natural sensitivity ratings for the different contaminant categories. These sensitivity ratings are conceptually based on the waterbody's type, size, and flow characteristics, along with general fate and transport characteristics of contaminant categories. For example, while rivers can move many contaminants great distances rather quickly, solvents tend to evaporate away as they more downstream. Ultimately, natural sensitivity ratings are used along with contaminant prevalence ratings (described below) to define a drinking water source's susceptibility to contamination.

2. Inventory of Potential Contaminant Sources (PCSs) – This inventory contains areal land cover percentages and a listing of specific facilities and sites, (e.g. landfills, Superfund sites) within the assessment area(s). Information contained in contaminant inventories is used to create Contaminant Prevalence ratings in the next step.

3. Susceptibility Determination – SWAP susceptibility ratings are created using the drinking water source's sensitivity and contaminant prevalence ratings. Sensitivity is defined using the water body type assigned during the delineation step, and contaminant prevalence values are assigned based on the nature of the potential contaminant sources present in the assessment area and the location (i.e. Zone 1 Vs Zone 2) of these potential contaminant sources relative to the drinking water source.

3.0 Assessment Area

3.1 Delineation and Assessment Area Background Information

The topographic assessment area delineation for this drinking water source is presented on the attached map. Details on the SWAP delineation process are presented in the attached Methods report. Additional PWS source identification and general assessment area information is presented in Table 1.

Additional information on this water system and source contained in the NYS DOH SWAP Database is presented in Appendix 1. In addition to information on local protection efforts, the NYS DOH SWAP Database may contains information and contamination concerns pointed out by the public water system or noted during sanitary surveys. Furthermore, the water supplier and/or the local health unit may have additional information not contained in the NYS DOH SWAP database.

3.2 Swap Sensitivity Ratings

This drinking water source's assigned waterbody type and SWAP natural sensitivity ratings are presented in Table 2. These sensitivity ratings are assigned using the table presented in the attached Methods report. The rationale for these ratings are based on the size and flow characteristics of the water body types, along with the fate and transport characteristics of the contaminant categories in each contaminant type classification.

The dominant considerations for defining natural sensitivity ratings for small lakes are their size and lack of high velocity and directional water flows. These waterbodies are assigned medium natural sensitivity ratings for the microbial, other chemical, and phosphorus contaminant categories. This is due to the tendency for microbial to undergo some inactivation or sedimentation, and these waterbodies tend to respond moderately to phosphorus problems with their watershed. The volatile natural of most organic chemicals makes these categories rate low for small lakes.

4.0 Contaminant Inventory and Suseptibility

Once a watershed assessment area for a particular water supply has been delineated (and natural sensitivity ratings assigned), contaminant inventories and contaminant prevalence and susceptibility ratings are created. To simplify these analyses and the presentation of results, the different types of available data are treated and reported

separately.

The overall contaminant inventory task in the assessment for surface drinking water sources consists of the compilation of land cover types (depicted as polygons in GIS) and discrete facilities and sites (depicted as points in GIS) within the delineated assessment area(s). First, the percentages of land cover types within the assessment area(s) are calculated. Next, contaminant inventories are created separately for those facilities with permitted discharges (Permitted Discharge PCSs) and other potential contaminant sources (Other Discrete GIS PCSs). This distinction was made because facilities with permitted discharges tend to be more important potential sources of contamination for surface waters, and these facilities have more useful information contained in their GIS databases. In contrast, the Other Discrete GIS PCS database does not contain much information beyond facility type (e.g. CBS, TRI, etc.). Consequently, susceptibility determinations based on these data are very general, often with susceptibility ratings being assigned to contaminant categories not even associated with PCSs within the assessment area. The final category of PCS in this report is Additional PCSs. This category includes PCSs that are depicted as lines in GIS (e.g. roads, pipelines) and those potential sources of contamination in the NYS DOH SWAP Database (or other available data, e.g. watershed reports, PWL list, etc.) that are not accounted for in the Other Discrete GIS PCSs inventories.

In order to simplify the SWAP process and allow for the clear presentation of results, contaminant inventories utilize contaminant categories (e.g. petroleum products, halogenated solvents), rather than individual contaminant names. These contaminant categories are based on similarities in origin, chemistr, fate and transport in the environment, and consequences in drinking water. The contaminant categories that have been identified as important to surface drinking water sources are presented in the glossary in the attached Methods report.

Once contaminant inventories are compiled, susceptibility ratings are separately created for each of the above mentioned data types. This is done by first creating contaminant prevalence ratings for each contaminant category based on the types of land cover and discrete PCSs present in the assessment area. These values are then used along with natural sensitivity ratings to assign susceptibility ratings for each contaminant category.

4.1 Land Cover

The land cover percentages for this assessment are presented in Table 3.

Land cover within the assessment area is inventoried and compiled to calculate contaminant prevalence ratings for each contaminant category, and these ratings are then used along with the watershed's natural sensitivity ratings to create the susceptibility ratings for the drinking water source. More details on this methodology are presented in the SWAP Plan and the attached Methods report.

The National Land Cover Data set (NLCD) data set is used to obtain land cover data in the SWAP. This data set was derived using Landsat images obtained

between 1988 and 1993. The images used were primarily collected during the spring leaves-off period, but fall leaves-off images, and various leaves-on images were also used. While this data set is generally considered to be a very good general land cover classification product, some inaccuracies still exist. The major problem with using this data set in SWAP is that it sometimes does not make accurate distinctions between row crops and pasture.

4.1.1 Contaminant Inventory

Land cover percentages within this assessment area are presented in Table 3. These percentages were compiled using the MRLC land cover data, and specific details on the SWAP land cover methodology is presented in the attached Methods report.

4.1.2 Contaminant Prevalence and Susceptibility

Contaminant prevalence and susceptibility ratings based on land cover are presented in Table 4.

Agricultural land cover results in medium contaminant susceptibility ratings for protozoa.

4.1.3 Additional Agriculture (AEM and CAFO) Data

Data related to the Agricultural Environmental Management Program (AEM) and Confined Animal Feedlot Operations (CAFOs) summarized in Table 5 are used to supplement the SWAP land cover data analysis. Densities are reported in this table as #s (animal units and acres) per 100 square mile, even though most assessment areas are smaller than 100 square miles. These unusual density units are used here to avoid the difficulties in presenting and reading very small decimal numbers (e.g. 0.0475 vs. 4.75).

AEM is a voluntary program designed to assist farmers in conducting an environmental assessment of their operations. Planning and technical guidance are made available to farmers who want to improve the environmental performance of their operations. Since information on specific farms is confidential as prescribed by AEM legislation, only summary data prepared for specific assessment areas are utilized in SWAP.

There are some important considerations when interpreting these data. First, summary AEM data are not available for all assessment areas, because not all counties provided information, and some delineations were not complete in time to be included. Also, not all farms participate in AEM, which means the summary AEM data may not adequately represent overall agriculture activates in some assessment areas. Overall, while this data set does have its limitations, it provides unique information for making assessments and a good starting point for local water quality protection efforts.

The DEC regulates farms engaged in animal husbandry that meet certain size criteria (i.e. large operations) through a permit program. Farms that meet the

size criteria are considered CAFOs and are obligated to implement control measures to prevent discharges to water bodies. Since GIS data were not available to SWAP until recently, these facilities and sites are not depicted on assessment area maps and contaminant inventory lists.+

There are no AEM data available for this assessment area, and CAFOs data supports the SWAP land cover analysis presented in section 4.1.

4.2 Permitted Discharges

The contaminant inventories for permitted discharges are derived from the DEC's SPDES program (and corresponding GIS layer), and two separate SWAP susceptibility determinations are performed using this data set. The first, more generalized analysis, reports the number of permitted discharges that are associated with each of the different contaminant prevalence and susceptibility ratings for each of the SWAP contaminant categories. The second type of susceptibility determination is strictly for the protozoan contaminant category. It is derived using data from the permitted discharges judged to be sanitary wastewater and estimates of total watershed wastewater and overall water flows.

4.2.1 Contaminant Inventory

The SPDES facilities located in this source's assessment area are displayed in the attached map and PD list.

4.2.2 Contaminant Prevalence and Susceptibility

General SPDES Contaminant Prevalence and Susceptibility ratings are presented on Table 6, and facility counts and densities are presented on Table 7. These ratings are derived using information contained in the DEC's GIS layer via the methodology presented in the SWAP plan and attached Methods report. It is important to note that these ratings are based on all of the contaminant categories that could be present at these facilities and sites, rather than what is actually present. Therefore, it is very likely that additional site specific information on PCSs will reduce the perceived risks to drinking water quality.

No permitted discharges were found in this assessment area.

4.2.3 Cumulative Wastewater Analysis

The results of the cumulative wastewater analyses are presented in Table 8. The facilities included in these calculations are marked as "SW" in the Wastewater column on the attached PD list.

This analysis of SPDES data evaluates the cumulative potential impact of surface wastewater discharges on a surface water PWS source's susceptibility to contamination by Protozoa (i.e. Cryptosporidium). The basic goals of these analyses are to first estimate the percentage of water that could be from wastewater effluent under low flow conditions, and then assign susceptibility based on the consequent potential levels of Cryptosporidium in the source water. It is important to note this methodology is rather crude, and these susceptibility ratings could be improved using site specific hydrologic data and more detailed information on specific wastewater facilities.

No permitted discharges were found in this assessment area.

4.3 Other GIS PCSs

The Other Discrete GIS PCSs include a variety of different types of DEC regulated facilities and sites. These facilities and sites include: Toxic Release Inventory (TRI), Landfill, Mines, Inactive Hazardous Waste Site (IHWS), Resources Conservation and Recovery Act (RECRA), Chemical Bulk Storage (CBS), Major Oil Storage Facility (MOSF), Hazardous Substances Emergency Events Surveillance (HSEES), Comprehensive Environmental Response Compensation and Liability Information System (CERCLIS), and Oil/Gas wells. Unlike the SPDES facilities, these facilities and sites do not have regulated discharges to the environment. The potential risks they pose to drinking water quality are associated with accidents and small unregulated releases over time.

4.3.1 Contaminant Inventory

The Other Discrete GIS PCS facilities and sites located in this source's assessment area are displayed in the attached map and CI list.

4.3.2 Contaminant Prevalence and Susceptibility

The Other Discrete GIS PCS ratings are presented in Tables 9 and 10. These ratings are derived using the methodology described in the SWAP PLAN and the attached Methods report. It is important to stress, the Other Discrete GIS PCS database generally does not contain information on the chemicals that are actually present at individual sites, and susceptibility ratings are created for all of the contaminant categories potentially released from each particular type of PCS. Therefore, it is likely that additional information on actual risks posed by specific facilities and sites will reduce the assessed threats to drinking water quality.

In order to further describe the risks to drinking water quality, the densities of these discrete PCSs are reported on Table 10. Densities are reported as number per 100 square miles, even though most assessment areas are smaller than 100 square miles. This was done to create meaningful, easy to understand numbers (i.e. without being too many places to the right of the decimal point) that allow density comparisons between assessment areas. Regardless,

additional information on particular PCSs would help to better define risks to drinking water quality.

None of these facilities were found within this assessment area.

4.4 Additional PCSs

Additional PCSs includes transportation routes, pipelines and other potential sources of contamination sources listed in the NYS DOH SWAP Database that are not accounted for in above mentioned GIS analyses.

Additional PCSs for this assessment area includes: septic system(s) and potentially other listed sources

5.0 Overall Susceptibility Discussion

The purpose of this section of the report is to use professional judgment to synthesize the findings of the overall assessment process in order to describe the greatest risk to drinking water quality for this source. The contaminant prevalence and susceptibility ratings presented above are largely the result of automated processes and generalized criteria. Furthermore, additional site specific information or studies would improve this assessment.

This assessment found a moderate susceptibility to contamination for this source of drinking water. The amount of pasture in the assessment area results in a medium potential for protozoa contamination. No permitted discharges are found in the assessment area. There are no noteworthy contamination threats associated with other discrete contaminant sources. Additional sources of potential contamination include: septics.

SUMMARY of SIGNIFICANT FINDINGS		
Potential Sources of Contamination	Potential Impacts to Water Source	Contaminants of Concern
Septic	Unknown	Microbial contaminants, Phosphorus
Agricultural Land Cover - pasture	Medium	Protozoa
Transportation Routes	low	various

NY3503527	C	FLORIDA VILLAGE	ORANGE
SMALL LAKE		GLENMERE LAKE	2571305

Table 1: System and Source Information

System Information			
System Name	FLORIDA VILLAGE		
Federal ID	NY3503527		
County Served	ORANGE		
Source Information			
TINWSF Number	2571305		
External System Number	47592		
Source Name	GLENMERE LAKE		
Water Body Area (acres)	333.72		
	Zone 1	Zone 2	
Watershed Area (sq miles)	2.52		
Watershed Area (acres)	1615.91		

*-99 means area could not be calculated in GIS

Table 2: Natural Sensitivity Ratings

Waterbody type: SMALL LAKE

Contaminant Types and Categories	Sensitivity Ratings
Organics =	Low
Halogenated Solvents	
Petroleum Products	
Other Industrial Organics	
Other Chemicals =	Medium
Pesticides Herbicides	
Metals	
Nitrates	
Sediments Turbidity	
Disinfection Byproduct Precursors	
Phosphorus =	Medium
Phosphorus	
Microbials =	Medium
Protozoa	
Enteric Bacteria	
Enteric Viruses	

Table 3: Land cover Percentages

Land Use Class	Zone 1	Zone 2
Water	22.06799	0
Low Intensity Residential	2.141369	0
High Intensity Residential	0.041256	0
High Intensity Commercial	0.453869	0
Pasture	9.957219	0
Row Crops	1.481662	0
Other Grasses	0.211641	0
Evergreen Forest	8.495490	0
Mixed Forest	38.32349	0
Deciduous Forest	15.71199	0
Woody Wetland	1.114023	0
Emergent Wetland	0	0
Barren; Quarries, Strip Mines, and Gravel Pits	0	0
Barren; Bare Rock and Sand	0	0
Barren; Transitional_including clear cut areas	0	0

Table 4: Land Use Susceptibility Analysis Summary

Contaminant Categories	CP Rating	Dominant land cover causing rating Z1	Dominant land cover causing rating Z2	Land cover notes	Susceptibility Rating
Organics					
Halogenated Solvents	LOW				
Petroleum Products	LOW				
Other Industrial Organics	LOW				
Other Chemicals					
Pesticides Herbicides	LOW				
Metals	LOW				
Nitrates	LOW				
Sediments_Turbidit	LOW				
Cations/Anions, Salts, Sulfate	LOW				
DBP Precursors	LOW				
Phosphorus					
Phosphorus	LOW				
Microbials					
Protozoa	MEDIUM	Pasture			MEDIUM
Enteric Bacteria	LOW				
Enteric Viruses	LOW				

Table 5: Summerized AEM and CAFO Data*

* An absent table means these data are not available for this assessment

Zone	# of CAFOs	CAFO Density per 100 ACRES	Rating
0	0	0.00	zero

NY3503527	C	FLORIDA VILLAGE	ORANGE
SMALL LAKE		GLENMERE LAKE	2571305

Table 6: Number of Permitted Discharge Facilities That Result in Particular Contaminant Prevalence and Susceptibility Ratings

* A blank table means none of these facilities were found for this assessment area.

Contaminant Categories	CP Ratings				Susceptibility Ratings					
	HIGH	MEDIUM	LOW	NEGLIGIBLE	VERY HIGH	HIGH	MEDIUM-HIGH	MEDIUM	LOW	NOTE

Table 7: Permitted Discharges, General SPDES Counts, Densities and Density Ratings

	Counts		#/100 Square miles		Rating	
	Zone 1	Zone 2	Zone 1	Zone 2	Zone 1	Zone 2
Surface WW	0		0.00		Zero	
Ground WW	0		0.00		Zero	
non WW	0		0.00		Zero	

Table 8: Cumulative Surface Sanitary Wastewater Analysis Results

* An absent table means none of these facilities are present or the SWAP methodology does not work for this assessment

Table 9: Contaminant Prevalence and Susceptibility Ratings for Other GIS PCSs

* A blank table means none of these facilities were found for this assessment area.

Potential Contaminant Sources	No. of Facilities	Halogenated Solvents	Petroleum Products	Other Indus Organics	Pesticides/Herbicides	Metals	Nitrates	Sediments/Turbidity	Cations/Anions/ Salts/Sulfate	DBP Precursors	Phosphorus	Protozoa	Enteric Bacteria	Enteric Viruses
CONTAMINANT PREVALENCE RATING														
SUSCEPTIBILITY RATING														

Table 10: Other Discrete GIS PCS Counts, Densities and Density Ratings

	Counts		#/100 Sqr Miles		Rating	
	Zone 1	Zone 2	Zone 1	Zone 2	Zone 1	Zone 2
CBS	0		0.00		Zero	
HSEES	0		0.00		Zero	
IHWS	0		0.00		Zero	
landfills	0		0.00		Zero	
Mines	0		0.00		Zero	
Oil Gas	0		0.00		Zero	
RCRA	0		0.00		Zero	
TRI	0		0.00		Zero	
MOSF	0		0.00		Zero	
CERCLIS	0		0.00		Zero	

NY3503527 C FLORIDA VILLAGE ORANGE

SMALL LAKE GLENMERE LAKE 2571305

NYS DOH SWAP DATABASE REPORT

Appendix 1

NYS DOH SWAP Database

I. System Level Info

A. Protection

1. Watershed Rules and Regulations? Yes *Details:* See WR&R

2. Existing Protection Description Watershed area inspected every six months

3. Jurisdiction of Source? Control limited to WR&R due to most of watershed not being owned by Village of Florida.

B. Water Quality Concerns

1. Concerns of LHU No

2. SWTR/DBP Issues No

3. System Treatment Concerns No

4. Significant Public Concern - Water Quality No

5. Significant Public Concern - Contaminants Yes

C. Other Available Information

1.

II. Source Information

A. Delineation

1. Delineation Description

2. Zones

3. Date 9/12/2002

4. Intake to Shore 20 *Depth* 2 *Units*

B. Potential Contamination

1. Significant Sum Survey Findings Scavenger waste site in watershed area Approx. 13,000' away from inlet
Sewer lines may be under Glenmere ave. approx. 75' from inlet.
Inlet is approx. 75' from Glenmere Ave.
Glenmere Homesite development is adjacent to reservoir, approx. 100 homes w/septic systems within 200 ft. of reservoir and approx. 5000 ft. from intake.
A horse farm is also located within the watershed approx. 1000 ft. from the reservoir and approx. 9000 ft. from the intake.
A small garden nursery is also located within the watershed approx. 4000 ft. from the reservoir and 11,500 ft. from the intake.
A small strip mall is located at the edge of the watershed approx. 8000 ft. from the reservoir and approx. 17,500 ft. from the intake.

2. Water Quality Concerns No

3. Existing Contaminant Inventory Date 9/12/2002

4. Surface Water Body Influence No *Distance*

NY3503527	C	FLORIDA VILLAGE	ORANGE
SMALL LAKE		GLENMERE LAKE	2571305

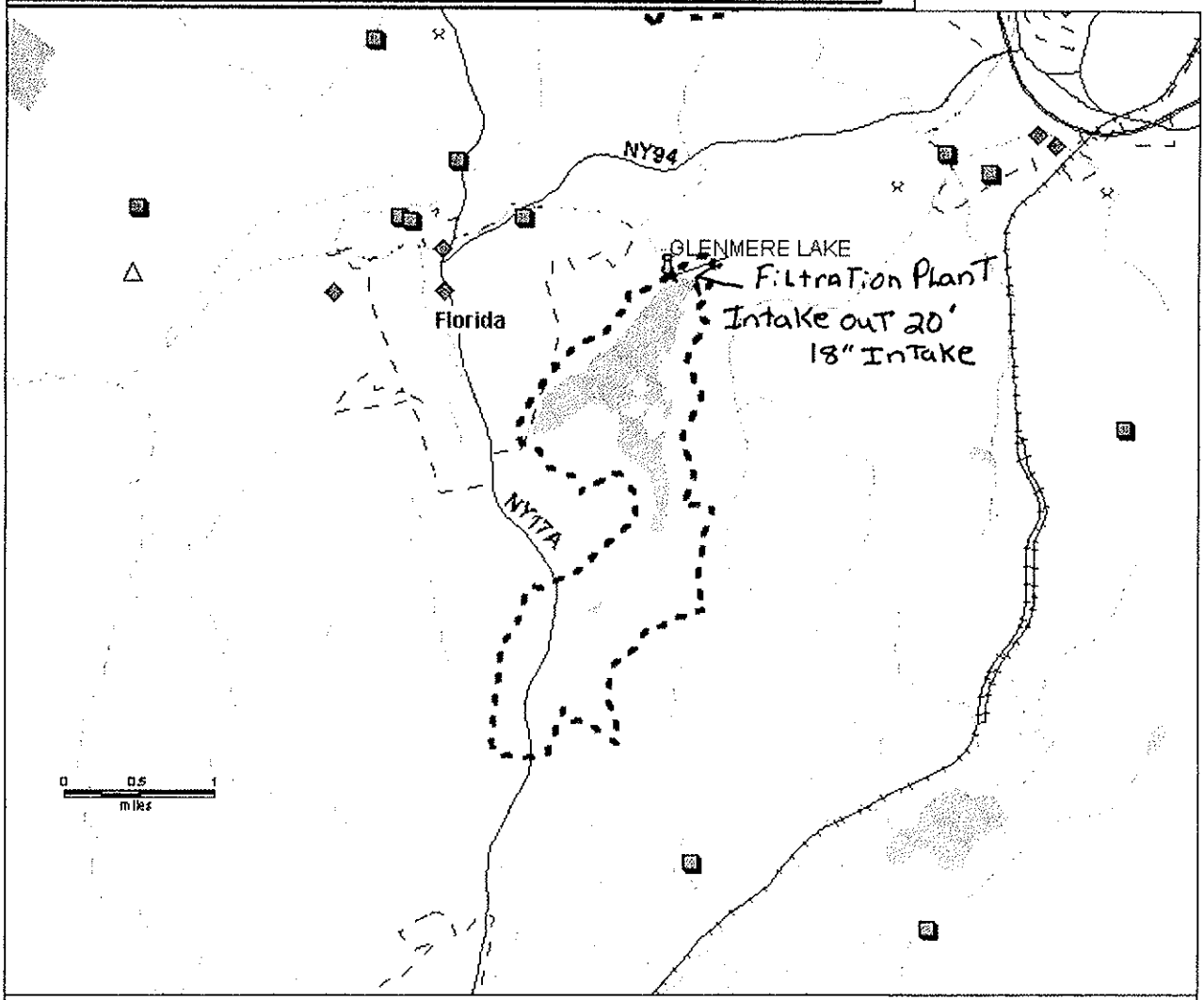
Description

5. Waterbody Quality

6. Source Structural or Locational Concerns

System_#	System_Name	County_Served
NY3503527	FLORIDA VILLAGE	ORANGE

Report_ID#	External_#	Source_Name	Waterbody_type
2,571,305	47,592	GLENMERE LAKE	SMALL LAKE



Railroads

Petroleum Pipelines

Major Roads

Surface Waters

Watersheds

Urban Areas

PWS intake

Permitted Discharge Potential Contaminant Sources

- Surface Water Sanitary Waste Discharge
- Non-Sanitary Waste Discharge
- Groundwater Sanitary Discharge

Other GIS Potential Contaminant Sources

- Chemical Bulk Storage
- Cerclis Sites
- Hazardous Subtance Spills
- Hasardous Waste Sites
- Landfills
- Mines
- Petroleum Bulk Storage
- Oil and Gas Wells
- RCRA facilities
- TRI facilities

STATE OF NEW YORK
DEPARTMENT OF HEALTH

Appendix B
Watershed Rules and Regulations

Rules and Regulations

for

The Protection from Contamination

of

The Public Water Supply

of

The Village of Florida

ORANGE COUNTY

Enacted by the New York State
Commissioner of Health
under
Chapter 45 of the Consolidated Laws
As finally amended by Chapter 510
of the Laws of 1921
(Public Health Law)

Rules and Regulations

for

The Protection from Contamination

of

The Public Water Supply

of

The Village of Florida

ORANGE COUNTY

Enacted by the New York State
Commissioner of Health
under
Chapter 45 of the Consolidated Laws
As finally amended by Chapter 510
of the Laws of 1921
(Public Health Law)

RULES AND REGULATIONS

The rules and regulations hereinafter given, duly made and enacted in accordance with the provisions of Sections 70, 71 and 73 of Chapter 45 of the Consolidated Laws (The Public Health Law) as amended by Chapter 510 of the Laws of 1921, shall apply to the entire drainage area of Glenmere Lake which forms the source of the public water supply of the Village of Florida, Orange County, N. Y.

The term "lake" wherever used in

these rules is intended to mean Glenmere Lake. The term "watercourse" wherever used in these rules is intended to mean and include every spring, pond, stream, ditch, gutter or other channel of any kind, the waters of which when running whether continuously or occasionally, eventually flow or may flow into Glenmere Lake.

Wherever a linear distance of a structure or object from the lake or from a watercourse is mentioned in these rules it is intended to mean the shortest horizontal distance from the nearest point of the structure or object to the highwater mark of the lake or to the edge, margin or precipitous bank, forming the ordinary highwater mark of such watercourse.

Privies Adjacent to Lake or Watercourse

(1) No privy, privy vault, pit, or receptacle of any kind used for either the temporary storage or the permanent deposit of human excreta, shall be placed, maintained or allowed to remain within seventy-five (75) feet of the lake or any watercourse tributary to the public water supply of the Village of Florida.

(2) No privy, privy vault, pit, cesspool or other receptacle used for the permanent deposit of human excreta shall be constructed, located, placed, maintained or allowed to remain within five hundred (500) feet of the lake or two hundred and fifty (250) feet of any watercourse tributary to the public water supply of the Village of Florida.

(3) Every privy, privy vault, pit, or other receptacle of any kind or place, used for the temporary storage of human excreta, located between the limiting distance prescribed by Rule (1) and the limiting distances prescribed by Rule (2) shall be arranged in such a manner that all such excreta shall be received in suitable watertight receptacles and shall at all times be disposed of as hereinafter set forth in Rules (4) and (5).

(4) The excreta collected in the aforesaid removable receptacles shall be removed and the receptacles cleaned and deodorized as often as may be found necessary to maintain the privy in a proper sanitary condition and to effectually prevent any overflow upon the soil or upon the foundation or floor of the privy. In effecting this removal the utmost care shall be excercised that none of the contents be allowed to esape in being transferred from the privy to the place of disposal hereinafter specified and that the least possible annoyance

and inconvenience be caused to the occupants of the premises or of the adjoining premises.

(5) Unless otherwise specifically ordered or permitted by the State Commissioner of Health, the excreta collected in the aforesaid receptacles shall when removed be disposed of by burying in trenches or pits at a depth of not less than twelve (12) inches below the surface of the ground and in such a manner as to effectually prevent their being washed over the surface of the ground by rain or melting snow and at a distance of not less than five hundred (500) feet of the lake or two hundred and fifty (250) feet of any watercourse tributary to the public water supply of the Village of Florida.

(6) Whenever it shall be found that owing to the character of the soil or of the surface of the ground or to the height or flow of subsoil or surface water, or other special local conditions, the excremental matter from any privy or aforesaid receptacle, or from any trench or place of disposal may, in the opinion of the State Commissioner of Health, be washed over the surface of the ground or through the soil into the lake or any watercourse tributary to the public water supply of the Village of Florida, then the said privy or receptacle for excreta, or the trench or place of disposal shall, after due notice to the owner thereof, be removed to such greater distance or to such places as shall be considered safe and proper by the State Commissioner of Health.

Sewage, House Slops, Sink Wastes, Etc.

(7) No house slops, bath water, laundry or garage wastes, sewage or excremental matter from any watercloset, privy or other source, shall be thrown, placed, led, conducted or discharged or allowed to escape or flow in any manner either directly or indirectly into the lake or any watercourse tributary to the public water supply of the Village of Florida, nor shall any such matter be thrown, placed, led, discharged or allowed to escape or flow onto the surface of the ground or into the ground beneath the surface, except into watertight receptacles, the contents of which are to be removed as provided by Rule (4) within five hundred (500) feet of the lake and two hundred and fifty (250) feet of any watercourse tributary to the public water supply of the Village of Florida.

(8) No garbage, putrescible matter, kitchen or sink wastes, refuse or waste matter from any dairy, cheese

factory, no water in which milk cans, utensils, clothing, bedding, carpets, or harness have been washed or rinsed, nor any polluted water or liquid of any kind shall be thrown or discharged into the lake or any watercourse tributary to the public water supply of the Village of Florida, nor shall any such liquid or solid matter be thrown or discharged upon the surface of the ground or into the ground below the surface except into watertight vessels or receptacles, the contents of which are to be removed as provided by Rule (4) within a distance of one hundred (100) feet of the lake or any watercourse tributary to the public water supply of the Village of Florida.

(9) No clothing, bedding, carpet, harness, vehicle, receptacle, utensil, nor anything that pollutes water, shall be washed, rinsed or placed in the lake or any watercourse tributary to the public water supply of the Village of Florida.

Bathing, Animals, Manure, Compost, Etc.

(10) No person shall be allowed to bathe in Glenmere Lake within one thousand (1000) feet of the intake of the public water supply of the Village of Florida, nor shall any animal or poultry be allowed to stand, wallow, wade or swim in Glenmere Lake or any watercourse tributary thereof, nor be washed therein. No watering place of any kind shall be maintained in such a way as to pollute with muddy leachings or excremental matter the waters of the lake or any stream tributary to the public water supply of the Village of Florida.

(11) No stable for cattle or horses, barnyard, hogyard, pigpen, poultry house or yard, hitching place or standing place for horses or other animals, manure pile or compost heap, shall be constructed, placed, maintained or allowed to remain with its nearest point less than one hundred (100) feet of the lake or any watercourse tributary to the public water supply of the Village of Florida, and none of the above named objects or sources of pollution shall be so constructed, placed, maintained or allowed to remain where or in such a manner that the drainings, leachings or washings from the same may enter the lake or any tributary watercourse, without first having passed over or through such an extent of soil as to have been properly purified, and in no case shall it be deemed that proper purification has been secured unless the above drainings, leachings or washings shall have percolated over or

through the soil in a scattered, dissipated form and not concentrated in perceptible lines of drainage, for a distance of not less than one hundred (100) feet of the lake or any watercourse tributary to the public water supply of the Village of Florida.

(12) No human excreta and no compost or other matter containing human excreta shall be thrown, placed or allowed to escape into the lake or tributary watercourse, nor to be placed, piled or spread upon the surface of the ground at any point on the watershed tributary to the public water supply of the Village of Florida nor shall such human excreta or compost or other matter containing human excreta be buried in the soil at a less depth than twelve (12) inches below the surface of the ground nor within a distance of five hundred (500) feet of the lake or two hundred and fifty (250) feet of any watercourse tributary to the public water supply of the Village of Florida, and no manure or compost of any kind shall be placed, piled or spread upon the ground within a distance of one hundred (100) feet of the lake or any watercourse tributary to the public water supply of the Village of Florida.

(13) No decayed or fermented fruit or vegetables, cider mill wastes, roots, grain or other vegetable refuse of any kind shall be thrown, placed, discharged or allowed to escape or pass into the lake or any tributary watercourse nor shall they be thrown, placed, piled, maintained or allowed to remain in such place that the drainings, leachings or washings therefrom may flow by open, blind or covered drains or channels of any kind into the lake or any tributary watercourse without first having passed over or through such an extent of soil as to have been properly purified and in no case shall it be deemed that sufficient purification has been secured unless the above mentioned drainings, leachings or washings shall have percolated over or through the soil in a scattered dissipated form and not concentrated in perceptible lines of drainage for a distance of not less than one hundred (100) feet before entering the lake or watercourse tributary to the public water supply of the Village of Florida.

Dead Animals, Offal, Manufacturing Wastes, Etc.

(14) No dead animal, bird, fish or any part thereof nor any offal or waste matter of any kind shall be thrown, placed, discharged or allowed to escape or to pass into the lake or any watercourse tributary to the pub-

lic water supply of the Village of Florida, nor shall any such material or refuse be so placed, maintained or allowed to remain that the drainings, leachings or washings therefrom may reach the lake or tributary watercourse without having first percolated over or through the soil in a scattered, dissipated form and not concentrated in perceptible lines of drainage for a distance of three hundred (300) feet from the lake or any watercourse tributary to the public water supply of the Village of Florida.

Fishing, Boating and Ice Cutting

(15) No boating of any kind or fishing from boats or through the ice and no ice cuttings or any trespassing whatever shall be allowed in or upon the waters or ice of Glenmere Lake, within three hundred (300) feet of the water supply intake of the Florida Water Works Company. Strict sanitary supervision shall be maintained by the Water Company over all ice cutting operations on Glenmere Lake beyond the above specified distance in order to prevent pollution of the supply from the workmen or horses engaged in the ice cutting.

Camps

(16) No temporary camp, tent, building or other structure for housing laborers engaged on construction work or for other purposes shall be located, placed or maintained within a distance of five hundred (500) feet of the lake or any watercourse tributary to the public water supply of the Village of Florida.

Cemeteries

(17) No interment of a human body shall be made within a distance of five hundred (500) feet of the lake or any watercourse tributary to the public water supply of the Village of Florida.

Inspections

(18) The Florida Water Works Company or such other board as may be charged with the maintenance or supervision of the public water supply of the Village of Florida or its duly appointed representative, shall make regular and thorough inspections of Glenmere Lake and all streams and drainage areas tributary thereto for the purpose of ascertaining whether the above rules and regulations are being complied with, and it shall be the duty of said company to cause copies of any rules and regulations violated to be served upon the persons violating the same with notices of such violations and if such persons served do not immediately comply with the rules and regulations it shall be the further duty of the Water Company

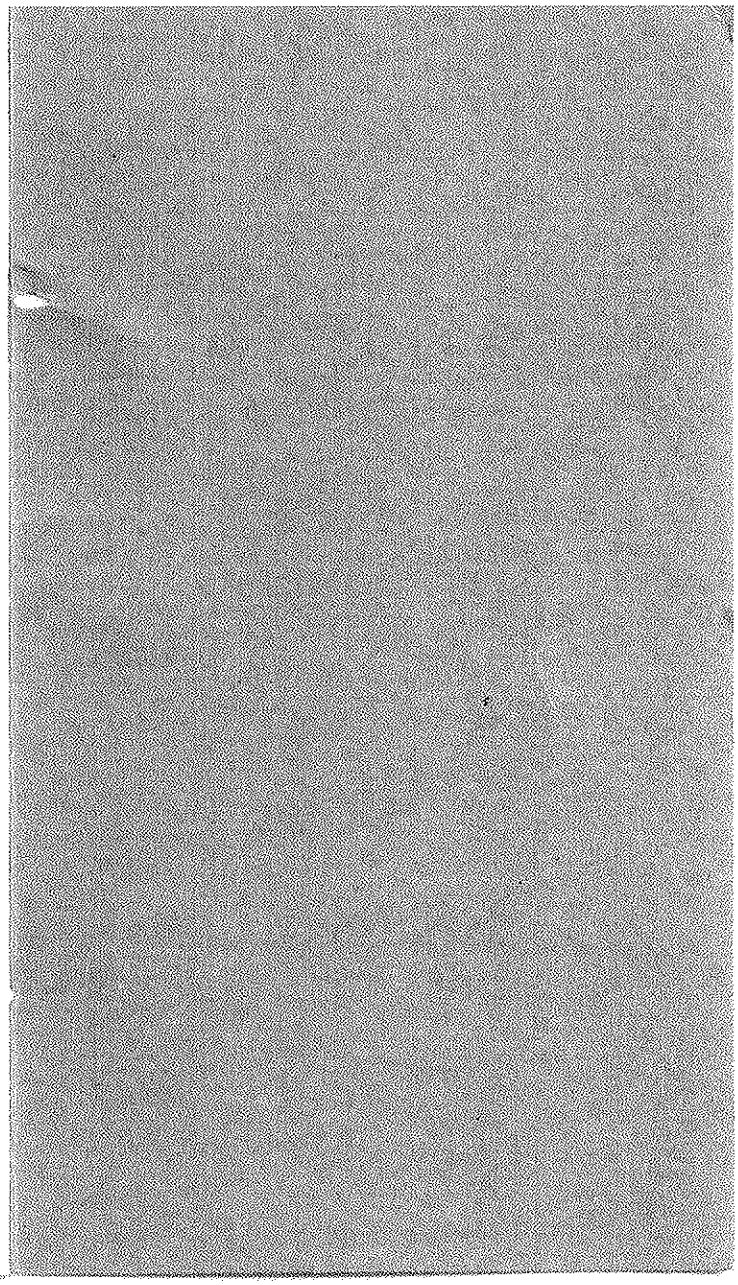
to promptly notify the State Commissioner of Health of such violations. The Water Company shall report in writing annually on the 1st of January the results of the regular inpections made during the preceding year, stating the number of inspections which have been made, the number of violations found, the number of notices served and the general condition of the watershed at the time of the last inspection.

Penalty

(19) In accordance with Section 70 of Chapter 45 of the Consolidated Laws (The Public Health Law) the penalty for each and every violation of, or non-compliance with, any of these rules and regulations which relate to a permanent source or act of contamination, is hereby fixed at one hundred ($100.00) dollars.

The foregoing rules and regulations for the protection from contamination of the public water supply of the Village of Florida, are hereby duly made, ordained and established on this 6th day of November, 1925, pursuant to Chapter 45 of the Consolidated Laws (The Public Health Law) of the State of New York, as amended by Chapter 510 of the Laws of 1921.

PAUL B. BROOKS
Dep. Com. of Health Albany, N. Y.



Appendix C
Watershed Inspection Form

NEW YORK STATE DEPARTMENT OF HEALTH
Bureau of Water Supply Protection

Annual Report on Violations of Watershed Rules and Regulations for the Calendar Year 20____

Section A. Identify Information

Year action taken 20 _____ Enforcement of Rules and Regulations Part _____

Public Water Supply _____

Water Board or Company _____

Municipality _____ County _____

Section B. Inspections/Violations

Specify details of violations on reverse side.

1. Number of Inspections during the year 20 _____ was _____

2. Total number of:

Violations found _____ Specify section of the Rules violated _____

Notices served _____ Specify section of the Rules violated _____

Violations corrected _____ Specify section of the Rules violated _____

3 Total number of violations remaining uncorrected as of January 1, 20 _____ is _____

4. Do you wish to update or revise your rules? ☐ Yes ☐ No

Section C. Sanitary Conditions

Provide all pertinent information bearing upon the general conditions on the watershed of the supply or in the vicinity of wells or springs used as the sources of water supply:

Signature (Water Supply Official) _____

Print Name _____

Title _____ Date ____ ____ ____
MM DD YY

Section D. Details of Violations

VIOLATION 1

Name of Violator

Post Office Address of Violator

Township/Village of Violation

Detailed Description of Violation and Rule(s) Violated

VIOLATION 2

Name of Violator

Post Office Address of Violator

Township/Village of Violation

Detailed Description of Violation and Rule(s) Violated

VIOLATION 3

Name of Violator

Post Office Address of Violator

Township/Village of Violation

Detailed Description of Violation and Rule(s) Violated

Appendix D
Summary of Management Strategies

Summary of Management Strategies for Glenmere Lake Watershed

Management Strategy	*"Pros"*	*"Cons"*	*Timing/Commitment*	*Approximate Cost*	*Recommended by Glenmere Lake Watershed Plan?*
Vegetation Management					
Chemical application: Sonar	Reduces vegetation which can improve performance of the water treatment plant and reduce taste and odor complaints as well as disinfection byproducts	Requires addition of a chemical to a public water supply; toxicity is not well-documented but its use in public water supplies is not allowed in some states	May need to be repeated depending on success	High	No
Chemical application: copper sulfide	Reduces algae, which can improve performance of the water treatment plant and reduce taste and odor complaints as well as disinfection byproducts	Requires addition of a chemical to a public water supply; copper can be toxic to aquatic organisms.	Needs to be repeated	High	Yes, but decrease when feasible
Biological control: introduction of weevils	May be effective for controlling aquatic vegetation	Effectiveness has not been proven in all cases; weevils also eat other plants in addition to milfoil.	May need to be repeated depending on success	Medium	No
Biological control: introduction of grass carp	Effective for controlling aquatic vegetation	Difficult to gain approval by NYS DEC, and desired aquatic plants may be harmed; nutrients and turbidity may increase	May need to be repeated depending on success	Medium	No
Dredging	Effective for removing aquatic vegetation	Not selective; Significant disturbance of fisheries and other habitats; increased trubidity in Lake water; difficult to gain approval by NYS DEC	Repeated dredging is not needed for many years	High	No
Physical control: Hand-Harvesting	Selectively targets vegetation of concern	Labor-intensive; may need to be repeated	May need to be repeated depending on success	High	Yes
Physical control: Suction-harvesting	Selectively targets vegetation of concern	Labor-intensive; may need to be repeated	May need to be repeated depending on success	High	Yes
Physical control: Mechanical harvesting	Effective for removing aquatic vegetation	Not selective and may spread invasive species	May need to be repeated depending on success	High	No
Physical control: Benthic barriers	Effective for killing aquatic vegetation	Not selective; Significant disturbance of fisheries and other habitats.	May need to be repeated depending on success	High	No
Physical control: Water level drawdown	Effective for killing aquatic vegetation	Not selective and not feasible for a public water supply	May need to be repeated depending on success	High	No
Aeration	Increases dissolved oxygen and reduces algae; may help control some types of aquatic vegetation	May not be effective for controlling the problematic aquatic vegetation	Ongoing commitment	High	Possibly, if cost-effective

Summary of Management Strategies for Glenmere Lake Watershed

Management Strategy	*"Pros"*	*"Cons"*	*Timing/Commitment*	*Approximate Cost*	*Recommended by Glenmere Lake Watershed Plan?*
Water Supply Management Strategies					
Update the safe yield analysis	Will allow allocation of water to other uses and resources	None/expense	Does not need to be repeated unless conditions change	Medium	Yes
Identify and secure a backup water supply	Will provide necessary redundancy and reduce vulnerability	None/expense	Ongoing commitment to maintain the backup	High	Yes
Disinfection byproducts management: reduce water age	Reduce disinfection byproducts	Requires tank volume control and/or mixing, system looping, and other improvements	Ongoing commitment	High	Yes
Disinfection byproducts management: TOC reduction	Reduce disinfection byproducts	Requires treatment plant modifications or vegetation and algae contol (see above)	Ongoing commitment	High	Yes
Monitoring					
Water quality monitoring	Will provide information that is currently lacking	Results only meaningful if continued for some time	Ongoing commitment	Medium	Yes
Vegetation monitoring	Will provide unbiased information that is currently lacking	Results only meaningful if continued for some time	Like an ongoing commitment	Medium	Yes
Stormwater Management					
Install centralized facilities/BMPs: Glenmere Homesites	Reduces sedimentation and pollutant movement downstream	Requires adequate space	Ongoing commitment to maintain the facilities	High	Yes
Elimination of point discharges to lake	Reduces any potential pollution of lake	Requires alternative to the discharge such as locating another outfall	One time effort	High	Yes
Install centralized facilities/BMPs: Hillman Road area	Reduces sedimentation and pollutant movement downstream	Requires adequate space	Ongoing commitment to maintain the facilities	High	Yes
Install in-line water quality basin: upstream Minturn Rd	Reduces sedimentation and pollutant movement downstream	Requires adequate space and may require creativity to ensure continued instream habitat	Ongoing commitment to maintain the facilities	High	Yes
Stabilize eroding watercourses	Reduces sedimentation downstream	Must be accomplished with minimal impact to instream habitats	Repeated efforts may be needed in the future	High	Yes
Evaluate stormwater management at horse farm and improve if needed	Reduces sedimentation and pathogen movement downstream	Requires close coordination with landowner and users	Ongoing commitment to maintain the facilities	High	Yes
Land Management					
Require cleaning of watercraft before using in lake	Helps prevent invasive species	Requires space, facilities, and/or enforcement	Ongoing commitment	Low	Yes
Review pending and proposed developments	Helps ensure that environmental interests are addressed	Requires time commitment	Ongoing commitment	Low	Yes

Summary of Management Strategies for Glenmere Lake Watershed

Management Strategy	*"Pros"*	*"Cons"*	*Timing/Commitment*	*Approximate Cost*	*Recommended by Glenmere Lake Watershed Plan?*
Public Water Supply Watershed Overlay District	Additional protections for Glenmere Lake	Requires time commitment	Ongoing commitment	Low	Yes
Acquire land per Warwick CPPP	Potential additional protections for Glenmere Lake	Cost	One time effort, although maintenance may be necessary	High	Yes
Annual watershed inspections	Continue protections for Glenmere Lake	Requires time commitment	Ongoing commitment	Medium	Yes
Conduct a sanitary evaluation of the Glenmere Homesites	May lead to improved water quality	Requires close coordination with landowner and health department; may result in expenses for owners that need to make repairs	One time effort, although repairs may result	Medium	Yes
Remediation of brownfield site	Reduces contaminants at adjacent property	None/expense	One time effort (subject to NYSDEC follow-up)	High	Yes

"Low" costs have either no cost or they can be handled by existing municipal, county, or state personnel with few outside expenses.
"Medium" costs would require less than $100,000 to implement, and may include studies or investigations.
"High" costs would require a greater level of funding with identified sources, and may include capital expenditures for land acquisition or projects involving construction or infrastructure.